MACHINERY.

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A MODERN DRAFTING ROOM.

ONE IN WHICH THE HEATING, LIGHTING AND VENTILATION ARE SPECIAL FEATURES.

While in most modern manufacturing establishments the drawing office is regarded as a very necessary and important department, there are not many shops, we will venture to state, that have as commodious and well appointed rooms for the draftsmen as are provided in the recently finished office of the Schenectady Locomotive Works. It often occurs that the increase of business that comes to a prosperous company absorbs the most of their attention in the building of new shops and providing them with tools to meet the increased demands for their products. Meanwhile the drafting department becomes in a congested condition and is allowed to remain in that state for an indefinite period. When at last, in such instances, it becomes imperatively necessary to provide more room, the addition is often one that merely increases the floor space, while other conditions necessary to make such a room a comfortable and healthful working apartment receive no consideration whatever. In the office referred to, however, an attempt has been made to realize as far as feasible the ideal conditions which should exist and from a personal examination we may state that these conditions appear to be generally met.

During the past summer the general offices of the company were enlarged and at the same time the inadequate quarters of the drafting department were extended to relieve the existing congestion. Considerable thought was given to the general design and arrangement of the extension, and particularly to that for the drawing office. It was held by the parties designing the additions that the first requisite of such a department is that its rooms shall be healthful and comfortable; and to realize this condition, there must always be a constant and plentiful circulation which shall at all times provide fresh air at the proper temperature and at the same time remove the impure air. The second requisite and the one usually regarded as first, is, of course, plenty of light with a general absence of shadows. In the drawing room under consideration, the conditions mentioned are fulfilled and also many more that go to make up a well appointed department.

The Circulatory System.

It is, of course, necessary to provide artificial means for maintaining a constant circulation of air under all conditions of weather and temperature and also quite an elaborate system of hot and cold air pipes with suitable mixing dampers so that in winter there shall be no question of the air being fresh and still at the proper temperature. The Sturtevant system was installed and the exhauster is shown with some of the piping in outline in Fig. 4. The exhauster is directly driven by a General Electric motor and the fresh air, as it is drawn through, is tempered by passing over the coils of a steam radiator. The main part of the radiator is set directly in front of the fan and is so arranged that the tempered air may be by-passed, or it may be still further heated by passing over another radiator. The double-duct system of piping is used, one pipe being for hot air and the other for cold air. Mixing dampers are placed at the base of each flue and they are so arranged that any desired mixture of tempered or hot air may be obtained in the flues. Chains for operating these dampers pass up through the flues to the rooms above and will be observed in some instances in the engravings, Figs.

Fig. 1. View of the drafting room of the Schenectady Locomotive Works. The photograph from which this cut was made, was taken at night by the artificial illumination. The view shows a portion of the main room without the bays.

1 and 2, the chains being provided with handles for manipulation. As will be noticed by reference to these cuts and Fig. 3, the fresh-air registers admit the air to the room at a point about eight feet above the floor and the registers for the escape of the vitiated air are at the floor level. The latter communicate with a ventilating flue having its opening on the roof. The circulating system is expected to entirely change the air in the room four times an hour or once every fifteen minutes and as the cubic capacity of the room with its bays is probably over 50,000 cubic feet, it is evident that sufficient fresh air will be constantly supplied for a larger number of persons than will ever be employed in the department. The entrances for the fresh air being at the height given, a draught is avoided and the air is disseminated throughout the room without any perceptible movement.

The circulatory system includes the heating of the room and bays, but to provide for emergencies, steam radiators are placed at the windows, so that there ought never to be any trouble in keeping the office at a comfortable temperature during the coldest weather.

The Lighting Arrangement.

The photographs, from which the two engravings showing the interior of the room were made, were taken at night by artificial illumination. It is quite evident that the artificial lighting leaves little to be desired, although the cuts scarcely do the subject justice. The photographs showed considerable halation around each light, thus giving the effect of a glare which is entirely absent in the room itself. The apartment is lighted by inclosed arc lamps manufactured by the General Electric Co. as were the dynamo for the lighting system and marine type of vertical engine driving it. The arc lamps are inclosed in ground glass globes which diffuse the direct rays of light and throw the greater portion against the white ceiling to be reflected in all directions throughout the room. The walls, also being white, assist in the scheme of general reflection and diffusion so that

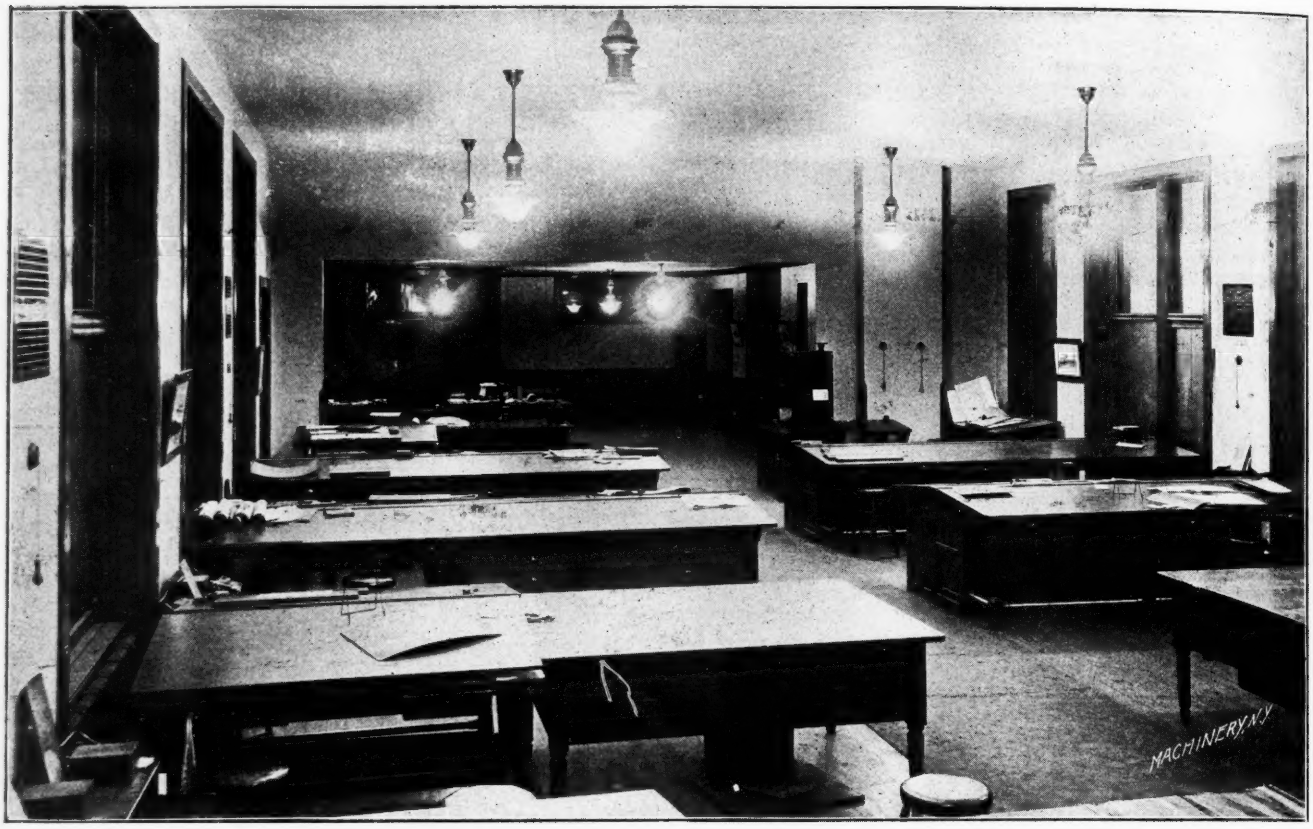


Fig. 2. Another view of the drafting room of the Schenectady Locomotive Works, taken from the opposite end of the room and also by artificial illumination. The vent registers show on a level with the middle of the windows.

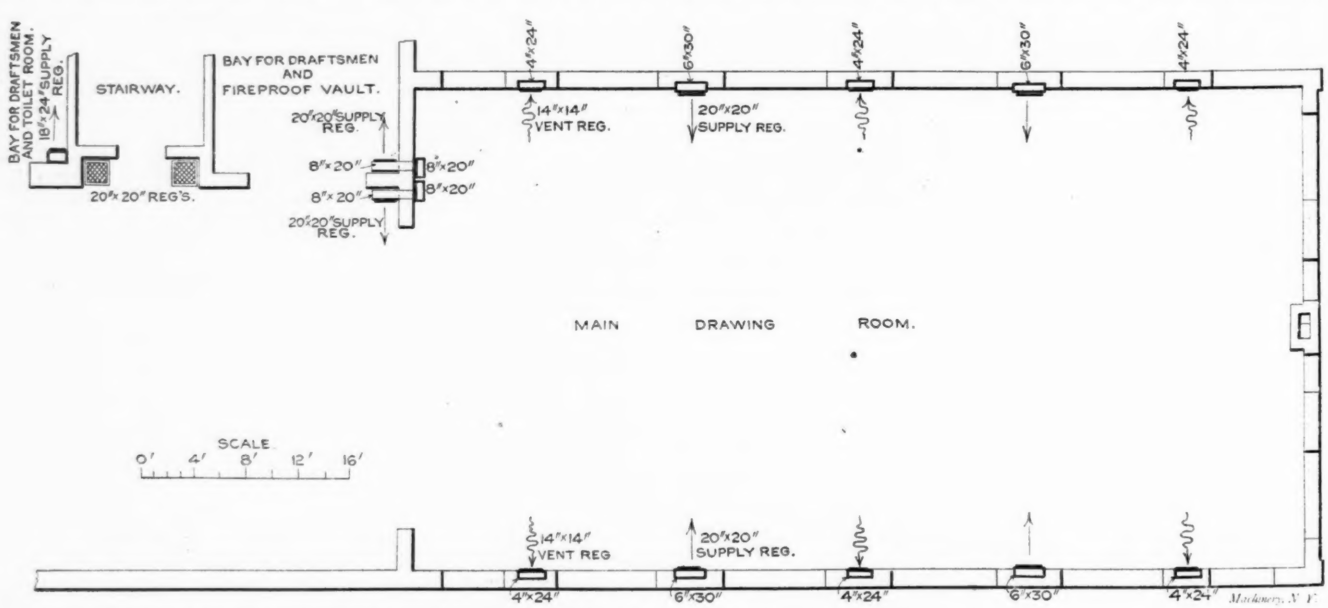


Fig. 3 Plan of the drafting room showing the arrangement of the heating and ventilating registers.

the entire room is filled with a soft white light that appears to have no definite source and thus causes an entire absence of shadows. It is needless to state that the effect on the eyes is very restful and is an agreeable contrast to most artificially lighted rooms.

While the artificial lighting is so successful, it is not more so than that afforded during the daytime, which is, of course, of the most importance. The windows are large and numerous and have single panes of ribbed glass in each sash. The ribbed glass has the peculiar feature of admitting practically as much light as the ordinary glass, but the light is broken up so that the rays

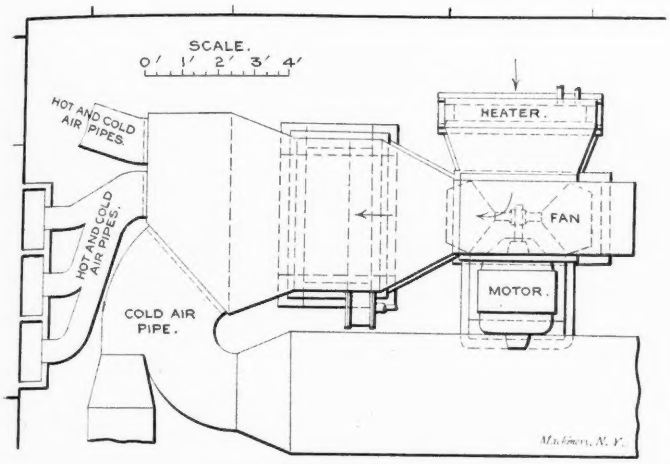


FIG. 4. PLAN OF THE FAN, MOTOR, HEATER AND HOT AND COLD AIR PIPES.

are diffused in all directions. The room is filled with a soft diffused light and there is a noticeable absence of shadows. The windows being on all sides of the room, the light always comes directly from the sun through some of the windows, but the shades are scarcely necessary on account of the diffusing power of the ribbed glass. There is one feature of the ribbed glass that might be objected to, and that is that outdoor objects cannot be discerned through it, and it is therefore not possible to relax the eyes by looking at distant objects. The changing of the focus from near to far objects is a grateful relief when the eyes become tired, but in such a large room as the one in question, this objection is probably not of much weight.

Other Features.

The drawing tables are solid, well-built pieces of furniture with hardwood tops. They are provided with drawers for the reception of paper, drawings and tracings in progress and the general paraphernalia of the draftsmen. Most of the tables are double, as shown, with the tops sloping in two directions, so that work can be carried on at both sides without interference. This arrangement favors the grouping of the draftsmen in divisions working on a common subject so that instructions may be given by the leader without interfering with the general order of the room. It favors a clear understanding of the work in progress by the men in the different divisions and leads to more general accuracy of the drawings, to say nothing of considerably increasing the amount of work done by the whole department.

A large part of the work, especially on the largest drawings, is done without a T-square and without the customary drawing-board. Heavy paper is used which lies smooth on the hardwood tops of the tables and lines are laid out by triangles and compasses, all lines being located from a common center line or a base line which is laid out at the beginning of the drawing. For smaller drawings and details the ordinary board and T-square is used the same as in ordinary practice.

The completed department, as it now stands, includes two bays which were a part of the old drawing office. One of the bays now contains tables for draftsmen and also a fireproof vault for the preservation of the drawings, tracings and other records of the department. The fireproof vault is two stories high, the lower part being used for the reception of the books and records of the general office. The other bay also has desks for draftsmen and a toilet room. Lockers for each employe are also provided, for hats, coats and other individual belongings.

PRINTING TITLES ON DRAWINGS.

A recent issue of the "American Engineer" contains a letter by Mr. F. M. Whyte, mechanical engineer for the New York Central Railroad, regarding a method which he uses for printing the titles on tracings by the aid of type and a printing press, instead of lettering the titles freehand, or with instruments, as is usual. As the idea is somewhat novel, and is evidently quite practicable, we reproduce the main portions of his description. He writes:

"In regard to the use of a printing press for printing titles on tracings, we are using a small handpress for this purpose, the frame of which measures 4 by 6 inches. When it was first proposed to purchase a printing press the one we have was considered sufficiently large; but it has been remarked several times since that it would have been better had we purchased a larger one. The length of the frame given above limits the length of the title, but we find it large enough for the purpose, as we try to make the title as short and expressive as possible. We have three fonts of type.

"I might tell you our experience which practically drove us to the adoption of a handpress. First, it costs considerable to put titles on drawings, whether the work is done with the usual drawing instruments or freehand. To reduce this cost, we tried first to use a rubber stamp, but the ink which we found would work satisfactorily with the rubber stamp would not give a print, so that, after putting the title on with the stamp, we would have to turn the tracing over and ink it on the back with black drawing ink. This, of course, was no great improvement on putting the titles on by hand. We found we could not use black ink on the rubber stamp, because the gasoline used for removal of the ink from the stamp after using it would destroy the rubber type. It was also difficult to get a perfect impression with the rubber stamp.

"The first difficulty experienced with the hand press was that the ink would not dry fast enough after the title had been put on the tracing, but this trouble was overcome by using a light, fine powder to absorb the ink, so that we now take a print from the tracing immediately after titling it. Fine powder should be used, because, otherwise, the large flakes of coarse powder will overhang the edge of the letter and produce ragged edges. We use the ordinary quick-drying printer's ink for our press. The first cost for us was $22.50 for the complete outfit, and it is believed that the first month or two's saving would cover the entire expense."

It is necessary to scrape the surface of the tracing cloth for the reception of the printed titles if the drawings are made on the glossy side. The following is the list of materials that I use: 1 press, 4 by 6 inches; 3 Hemple quoins and one key; 1 lot assorted wood furniture; 5 lbs. 2-point L. S. slugs; 5 lbs. 2-point L. S. leads; 1 8-inch composing stick; 1 8 by 12 ink stone; 1 font 6 point combination Gothic type; 1 font 18 point combination Gothic type; 1 font 12 point combination Gothic type; 2 fonts 2 point brass rule; 3 small cases two-thirds, size (for type); 1 lb. can quick-drying printer's ink.

* * *

In reporting the exhibits at the Philadelphia Commercial Congress, the "Philadelphia Record" mentioned several exhibits of iron articles which showed a beautiful dull black surface that was very attractive for such work. "Sparks" gives this explanation of the process as contained in the "Record":

It consists in coating the objects very uniformly with a thin layer of linseed oil varnish, and burning it off over a charcoal fire. During the deflagration the draught must be stopped. The varnish will first go up in smoke with a strong formation of soot, and finally burn up entirely. The process is repeated, i. e., after one coating is burned off a new one is applied, until the parts exhibit a uniformly handsome, deep black color. Next, wipe off the covering with a dry rag, and heat again, but only moderately. Finally the articles are taken from the fire and rubbed with a rag well saturated with linseed oil varnish. The black turns completely dull, and forms a durable covering for the objects.

* * *

The pressure exerted by a column of water is .434 pounds per square inch for each vertical foot of the column in height.

SCREW PITCHES IN FOREIGN COUNTRIES.

DATA UPON THE PITCHES OF SCREWS USED ABROAD AND THE GEARING FOR CUTTING THEM.

The various pitches of screw threads used in different parts of Europe, and even by different firms in the same country, have caused no little annoyance to makers of American machine tools who are manufacturing lathes for foreign shipment. To determine as far as possible what pitches these lathes are generally arranged to cut; whether the pitches are English or Metric units; and if the latter, whether metric lead screws are provided, or simply the usual screw, with translating gears for metric threads, we addressed letters of enquiry to a number of American firms, replies to which follow. We also publish replies from similar letters sent to a few foreign firms and engineers. To the fund of imformation thus accumulated is added a general review of the subject by Mr. Henry Harrison Suplee, the translator of Reuleaux's Constructor, whose extended study and experience render his opinion of exceptional value.

From Potter & Johnston Co., Pawtucket, R. I.:

"Our experience with the requirements of manufacturers in countries where the metric system is used would indicate that the use of two translating gears, with 50 and 127 teeth respectively, is entirely satisfactory and it is seldom that there is any call for lathes with metric lead screw."

From Fitchburg Machine Works, Fitchburg, Mass.:

"Our lathes for export have all been furnished with our regular lead screw and screw gears or with a metric lead screw and gears to cut metric thread. We have no demand for anything special beyond this."

From the Goddard Machine Co., Holyoke, Mass.:

"We have made no change in our lathes except to make them cut metric threads, which we do by adding two special compound gears to the regular outfit of the lathe. We furnish one each with 50 and 127 teeth. By far the larger part of the tools we export, however, are fitted to cut English threads."

From the F. E. Reed Co., Worcester, Mass.:

"We have orders from abroad for lathes, sometimes to cut American pitches and sometimes to cut metric pitches. When orders come for first named, we furnish simply our regular lathe. When the latter, we furnish our lathes with metric lead screw."

From the Brown & Sharpe Mfg. Co., Providence, R. I.:

"We would say that a common practice is to furnish an extra gear with 127 teeth (sometimes called a 'translating gear'), besides the regular set of change gears. This is based on the fact that 1 m/m = 5/127 of an inch almost exactly. By this method, if the lathe has a lead screw of one turn to the inch, gearing in the ratio of 5 to 127 would cut 1 m/m lead. If, however, the screw is not one turn to the inch, the gearing would be 5/127 × No. of turns per inch of lead screw, and if the thread to be cut is not one m/m lead, then the gearing would be 5/127 × No. of turns per inch of lead screw × the lead in m/m of screw to be cut.

SCREW CUTTING TABLE FOR 13" ENGINE LATHE FOR CUTTING METRIC THREADS.

Pitch to be Cut.	Gear on Spindle.	First on Stud.	Second on Stud.	Screw.
1 mm.	105	49	28	127
1.5 "	105	49	42	127
2 "	105	49	56	127
2.5 "	105	49	70	127
3 "	105	49	84	127
3.5 "	105	49	98	127
4 "	80	28	84	127
4.5 "	105	28	72	127
5 "	105	28	80	127
5.5 "	105	28	88	127
6 "	105	28	96	127
6.5 "	105	28	104	127

"The blue print enclosed shows the gears required for ordinary pitches in m/m, which, as far as we know, are those commonly used abroad.

"This table is for lathes with lead screws of six threads, or turns to the inch, geared 1 to 2, giving a ratio of 1/12.

"Example: Required the gears to be cut 5 m/m lead.

$$\tfrac{5}{127} \times 12 \times 5 = \frac{300}{127} = \frac{105 \times 80}{28 \times 127},$$

the required gears as per table.

"When a metric lead screw is provided, the ordinary change gears can usually be used. For example, a 13" or 16" lathe geared 1 to 2 with a lead screw of 4 m/m lead requires a ratio of 1 to 2 between the spindle and the screw to give 1 m/m lead on the screw being cut, and the same gears can be used as for the lathe with the pitch of the screw in inches."

From the Hamilton Machine Tool Co., Hamilton, Ohio.:

"We would say briefly that we have no exact knowledge as to what proportion of European tool users demand metric as against English or vice-versa. Our practice, however, is to furnish metric lead screws whenever required, with the necessary index plate and gears to cut a reasonable number of threads; the pitch or lead of the screw being decided by its convenience and the number of change gears required. To illustrate—with our 18" lathe we have adopted a 6 mm. lead screw (6 mm. pitch means in this case lead per rotation of screw) and we furnish gears to cut 1 mm., 1 5, 2, 2.5 and so up to 7, 7.5, 8, 9, 10 and 12. Change gears required to cut the above are as per table annexed.

INDEX PLATE FOR 18" LATHE WITH ENGLISH SCREW

Thread.	Stud.	Screw.
2	48	24
3	48	36
4	48	48
5	48	60
6	48	72
7	48	84
8	24	48
9	24	54
10	24	60
11	24	66
11½	24	69
12	24	72
13	24	78
14	24	84
16	20	80
18	20	90
20	20	100

INDEX PLATE FOR 18" LATHE WITH METRIC SCREW.

Pitch.	Stud.	Screw.
1 mm.	20	120
1.5 "	20	80
2 "	20	60
2.5 "	30	72
3 "	30	60
3.5 "	35	60
4 "	40	60
4.5 "	45	60
5 "	50	60
5.5 "	55	60
6 "	48	48
6.5 "	52	48
7 "	56	48
7.5 "	45	36
8 "	48	36
9 "	45	30
10 "	50	30
12 "	60	30

"The majority of our lathes are fitted with English screws and indexed for English threads. When it is desired to cut metric threads with an English screw outfit, we furnish a simple compounding attachment and a 50 and 127 tooth change gear in addition to the regular set, when by compounding, the operator is enabled to cut metric screw threads, and the index plate used for English threads will then indicate the same number of threads per centimeter that it usually indicates in English threads per inch."

From the Pratt & Whitney Co., Hartford, Conn.:

"Our lathes can be arranged for cutting threads to the metric system by making the head and change-gear studs long enough to receive a double train of gears, adding translating gears of 50 and 127 teeth for one train and using regular change gears for the second train. By this means the same number of threads per centimeter as per inch, and finer and coarser threads may be cut, as well as a greater variety of feeds obtained than under the regular construction. A number of our foreign customers prefer a metric lead screw, and, of course, when this is furnished the above special gears are not required."

From the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio:

"In regard to the threads used abroad, on most of our lathes that go to Germany and all that go to England, we send the regular standard thread as used in this country. On most of the lathes that go to France and some that we send to Holland, Belgium, Switzerland, Austria and Russia, we send about one-half metric and half United States standard.

NO. 1. SCREW-CUTTING INDEX, METRIC SYSTEM, 12", 14", 16" AND 18" LATHES.

Mm. Pitch.	Stud.	Screw.
.60	18	75
.70	21	"
.80	24	"
.90	27	"
1.	30	"
1.25	25	50
1.50	30	"
1.75	35	"
2.	40	"
2.50	40	40
3.	48	"
3.50	56	"
4.	64	"
4.50	72	"
5.	80	"
5.50	44	20
6.	48	"
7.	56	"
7.50	72	24
8.	64	20
9.	72	"
10.	80	"

NO. 2. CHANGE GEAR LIST FOR CUTTING METRIC PITCHES ON 12" LATHES.

Thr. Pitch in mm.	Stud.	Screw.
.7	24	71
.8	"	62
.9	"	56
1.	"	50
1.25	30	"
1.50	36	"
1.75	42	"
2.	48	"
2.50	60	"
3.	72	"
3.50	42	25
4.	48	"
4.50	54	"
5.	60	"
6.	72	"

"When we have a call for a metric pitch, we furnish our customer with a metric screw and special change gears cutting from .60 to 10 millimeter pitch as per table No. 1 enclosed herewith. However, we have had several calls for a lathe to cut both metric and U. S. standard thread. This we accomplish by furnishing an independent reverse plate and special gears which are figured out so that they come to within a limit

of from about .001 or .002 per inch either way. We do not use the compound of 127-50, but figure out the gears for each thread the same as we would, for example, if we had to cut six threads in 1—15/1000".

"Of course, you understand the ratio between the two systems is as 127 is to 50. This, of course, cannot be reduced and as 127 teeth make a very large gear, we have to take the closest thing we can to this and then figure our other gears so that the distance between the threads will be 1-2-3-4-5 millimeters, etc. When required to cut both U. S. and metric threads we simply cut from .07 to 6 millimeter pitch as per table No. 2.

"We have never had any complaint about our range and on our regular metric lead screw we have taken the pitches that were adopted at the International Congress at Zurich, 1897."

[The pitches mentioned above as having been adopted at Zurich are the same as those contained in the regular "Systeme Francais," commonly used in France, with the addition of two extra pitches to be used with diameters not included in the original system. These pitches have been kindly furnished us by Messrs. Hermann-Glaenzer & Co., Paris, and are printed below, together with the corresponding diameters, as far as we have been able to obtain them.—Editor.]

Diameter, Millimeters.	Pitch, Millimeters.	Diameter, Millimeters.	Pitch, Millimeters.
..	.60	36	4.
..	.70	42	4.50
..	.80	48	5.
..	.90	56	5.50
6	1.	64	6.
8	1.25	72	6.50
10	1.50	80	7.
12	1.75	88	7.50
14	2.	96	8.
18	2.50	116	9.
24	3.	136	10.
30	3.50		

From Lodge & Shipley Machine Tool Co., Cincinnati, O.:

"The only special thread that we arrange our lathes to cut to meet the requirements of the European market is 19. We furnish our lathes with metric lead screws if so required, making a special lead screw for the machine."

From Th. Peters, Director of the Society of German Engineers, Berlin:

"In answer to yours of the 14th inst., we beg to reply that it might be advisable if the 'lead screw' on turning lathes used to cut screws, for sale in Germany, were fitted out with a pitch of ½" English measurement, as at present most of the German machinery factories still use a screw based on the Whitworth scale and the old English inch, and in the transition to the metric screw it is necessary to insert a gear wheel with 127 teeth to make an English lead screw cut metric screws."

From DeFries & Co., Berlin and Wien, Germany:

"Answering your request, we enclose a schedule in which are given particulars in regard to screws as commonly used here in this country. It is as follows:

SCHEDULE OF SCREWS

No.	Diameter of Screw.		Pitch per inch.	Diameter at root of Thread	
	Inches.	Mm.		In Inches, English.	Mm.
1	¼	6.35	20	0.18	4.72
2	5/16	7.94	18	0.24	6.09
3	⅜	9.52	16	0.29	7.36
4	7/16	11.11	14	0.34	8.64
5	½	12.70	12	0.39	9.91
6	⅝	15 87	11	0.51	12.92
7	¾	19.05	10	0.62	15.74
8	⅞	22.22	9	0.73	18.54
9	1	25.40	8	0.84	21.33
10	1⅛	28.57	7	0.94	23.87
11	1¼	31.75	7	1.07	26.92
12	1⅜	34.92	6	1.16	29.46
13	1½	38.10	6	1.29	32.68
14	1⅝	41.27	5	1.37	35.28
15	1¾	44.45	5	1.49	37.84
16	1⅞	47.62	4½	1.59	40.38
17	2	50.82	4½	1.71	43.43
18	2¼	57.15	4	1.93	49.02
19	2½	63.50	4	2.18	55.37
20	2¾	69.85	3½	2.38	60.45
21	3	76.20	3½	2.63	66.80

METRIC SCREW THREADS.

HENRY HARRISON SUPLEE.

In view of the extending use of American machinery in countries in which the metric system is in general use there has been some inquiry as to the best method of adapting screw-cutting tools to metric screw-thread systems. Nearly all such inquiries assume that there exists in the metric system some standard system of screw threads such as the Sellers in America, or the Whitworth in England, and all that is needed is to procure standards and proceed to make taps and dies, and to equip lathes with appropriate lead screws and change-gears.

As a matter of fact there are so many different metric screw-thread systems that no standard really exists. The following list of so-called systems, which does not claim to be complete, will show that at least there is ample variety. Thus we have the systems of: Armengaud, Redtenbacher, Paris-Lyons-Mediterranean R. R., Northern Railway of France, J. F. Cail, the French Navy, two systems of Ducommun, the Engineering Society of Mulhouse, Reishauer & Bluntschli, Pfalz-Saarbruck, Society of German Engineers, two systems of Delisle, Reuleaux, and the Zurich International Congress. Each of these has been intended to supersede its predecessors, but it has been well said that it is much easier universally to adopt a new thing than it is universally to throw away an old one, and so each attempt to improve has only added one more to the confusion, and no permanent step toward a standard has been made.

These systems relate to threads for bolts, but as they extend for sizes up to 80 millimeters diameter, or more than 3 inches, it will be seen that they are intended to cover the great range of general shop work. For larger diameters, and for square or special threads, the profile and pitch are chosen by the designer, the sizes being expressed in millimeters and tenths.

There does not seem to be much consolation for the American maker of machine tools in all this, but as a matter of fact the metric-using nations have settled the thing very neatly themselves by using the English Whitworth standard in nearly every case, and paying no attention to any of the proposed metric systems. In the best shops of Switzerland and Germany, bolts and nuts are made with the dimensions in English inches and fractions thereof, and with the form and pitch of threads conforming to the Whitworth standard.

In regard to screw-cutting lathes, the problem of cutting metric threads can be solved in a very simple manner to a very close degree of approximation. As is well-known, there are almost exactly 25.4 millimeters in an inch, and so with a lead screw of one-inch pitch, and with change gears of 10 and 254 teeth, a screw of one millimeter pitch would be cut. As a matter of practice this is simply modified by making the lead-screw of half-inch pitch and the corresponding change gear of 127 teeth. The result is that a 10-tooth gear on the spindle will cut one millimeter pitch, an 11-tooth gear, 1.1 millimeter pitch; a 15-tooth gear, 1.5 millimeter pitch, and so on for every decimal of a millimeter. The precision of this method will be seen when it is understood that the error would amount to only 0.00008 of an inch in one meter, an amount which is quite within the limits of the precision of our knowledge of the true relation of the meter and the inch, and doubtless within the limits of accuracy of the lead screw of a commercial lathe.

Under these circumstances, therefore, there seems to be no good reason for agitation about the equipment of American lathes with metric lead screws, nor of any attempt to produce standard metric dies and taps. Standard Whitworth threads can readily be made on American tools by the use of commercial dies, and metric threads cut on American lathes by the addition of but one extra gear, and it is difficult to see how the situation could be simplified.

* * *

A course in "sugar engineering" is a new development at one of our progressive colleges. The college giving it, however, is neither Wellesley nor Vassar, as might be inferred. The students attending these two institutions are supposed to be so well versed in this branch that further instruction in it would be superfluous. The course is given at Tulane University, Lexington, Va., to fit students to take responsible charge of both the mechanical and chemical work connected with the sugar making industry. It is held that the mechanical engineers and chemists who have made more or less of a specialty of sugar making machinery and processes do not exactly satisfy the demand for an all-around man, who is familiar with both the mechanical and chemical sides of the industry, and who is capable of taking intelligent general direction of a sugar-making plant. It is primarily with the object of supplying this need and of offering a suitable training for the sons of sugar planters that this course has been planned.

AN HOUR IN ONE OF THE OLDER SHOPS.

NOVEL EXAMPLES OF DRILL FEEDS AND EPICYCLIC GEARING.

One of the older New England shops is that of the Humphrey Machine Co., Keene, N. H. The proprietor, Mr. J. Humphrey, has been closely identified with the water wheel industry of the country for many years and is a well-known authority upon the subject of hydraulics. His shop is not a large one, but the class of work that it has been called upon to do during a period of nearly 40 years has been so varied, both in size and kind, that could we describe the ways and means adopted to turn out the work, it would afford many a page of instructive reading. In most shops where jobbing is done, snags are encountered that tax both ingenuity and patience to the utmost; but couple with these snags the difficulties that had to be overcome in the days when no special tools were to be had, and but few sizes of lathes, planers and one or two other lines of standard tools were made, and it will be understood why so many of the older shops are interesting places for one to visit, if he appreciates ingenuity in machine work.

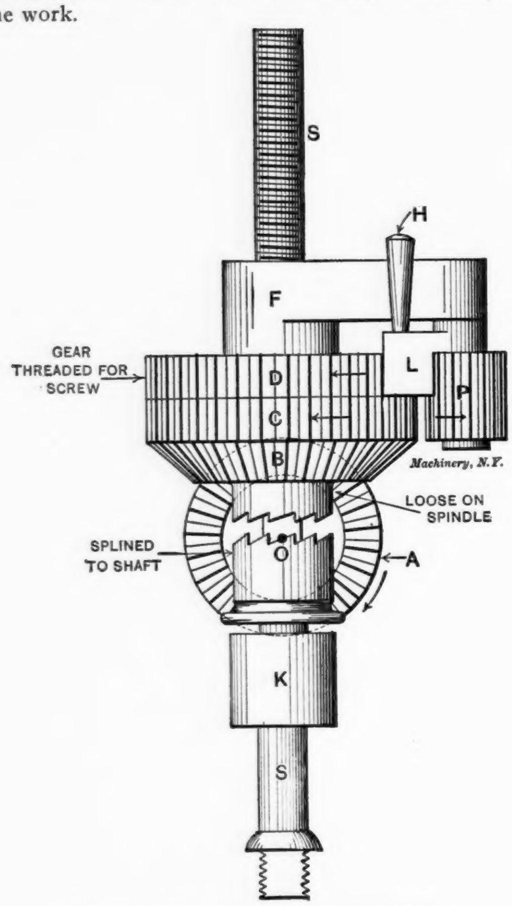


FIG. 1. COMPACT FEED ARRANGEMENT.

In this shop, for example, is a boring mill that was built by Mr. Humphrey when boring mills could not be bought as readily as now, and probably if they could have been, there would not have been enough work for it to do to warrant the expenditure. This machine is nominally a "nine-foot" mill that, in its day, was the largest machine in the country around—and perhaps it is today—for this particular corner of New England has not been blessed with many machine industries. This boring mill has a wooden frame and is capable of being jacked up indefinitely, to take work of almost any capacity that may be required. In fact, the height and diameter of such work as it may be required to do appear to be immaterial. The machine has power feed, will bore and turn at any angle and altogether has seemed to be too useful an adjunct to the shop to be discarded.

For strict originality, however, the two drilling machines which are shown in outline in the accompanying sketches easily take precedence. Mr. Humphrey calls these machines "somewhat interesting as curiosities," but does not consider them very useful for general purposes or very creditable to their maker. In this regard we must beg to take issue with him, for although they were built in the early sixties, they possess features worthy of study, even by "20th century" designers.

The earlier drills that we occasionally see, while they have the power feed, generally lack the quick-return feature that is so essential to rapid work. The drills designed by Mr. Humphrey, however, not only have the quick-return, but one of them feeds through epicyclic gearing and the whole arrangement of both of them is novel.

In Fig. 1 is a small swivel drill that was intended to drill radial holes on the inside of the arc of a circle. Only the spindle and feed mechanism are shown, but the machine itself is bolted to a column in the shop and swivels about the point O, so that it will drill in any direction in one plane. F and K are bearings supporting the spindle S, the upper end of which is threaded. The spindle is driven through the medium of the bevel gears A and B and the clutch O, which is splined to the shaft. Gear B is loose on the spindle and can drive it only when the clutch is thrown in.

The feed is through gear C, which is in one piece with the bevel gear B, the gear D and pinion P, which latter acts as an idle gear. Gear D has one or two less teeth than gear C, although of the same diameter, and pinion P can be moved into contact with the two gears by rotating an eccentric bushing on which it runs. The hole in gears C and B is a free-running fit on the spindle, but the hole in D is threaded to accommodate the threaded part of the spindle. When the pinion P is moved into gear with C and D and the clutch is thrown in, the spindle rotates at the same speed as gear C; but gear D, having a less

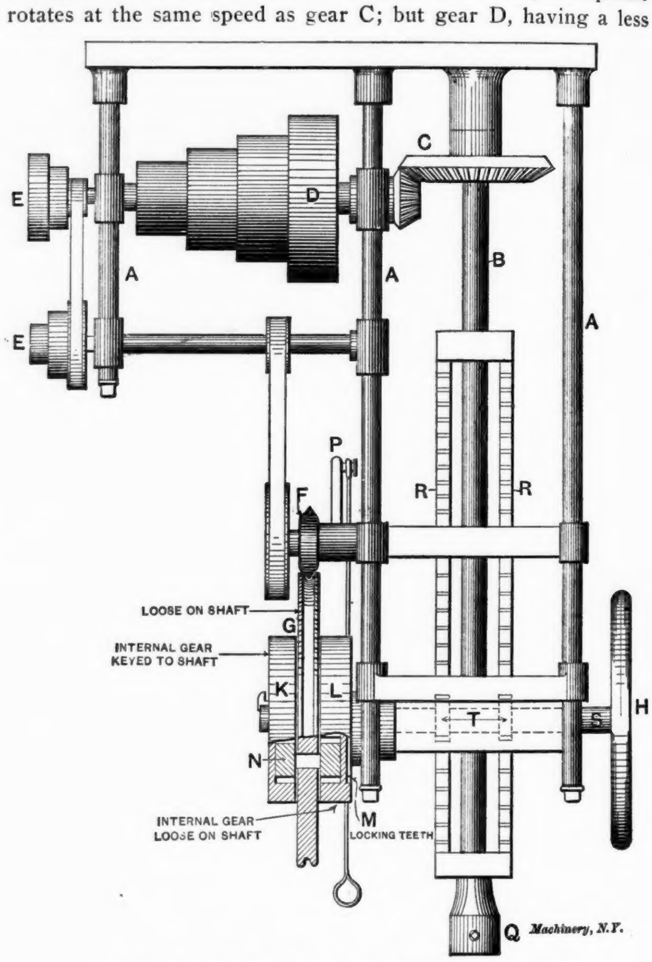


FIG. 2. SUSPENSION DRILL WITH EPICYCLIC FEED.

number of teeth than C and being driven from C through pinion P, rotates slightly faster than the spindle and wheel C, and therefore gradually screws the spindle downward.

If it be desired to move the spindle downward more rapidly when getting the drill into position, the clutch is thrown out. This stops the rotation of the spindle, and D will then turn at a greatly augmented speed relative to the spindle and will screw it downward much faster.

For the quick return, pinion P is moved out of gear by the handle H, which also pushes the brake L against the teeth of gear D and keeps the latter from turning. The clutch is then slid into contact and the spindle is driven while D remains stationary as long as the brake is in contact. This makes the relative motion of the spindle and gear opposite to what it was before and the spindle is returned quickly to the desired position.

A good suspension drill is a useful machine and the one shown in Fig. 2 was pronounced by one of the men who has used it for several years as the best tool of the kind that he ever saw. That it has good features, we think our readers will admit. It not only has a power feed, but a quick return which can be operated much easier than those on some modern drill presses, where a square-jawed clutch must be moved in or out before the spindle can be returned. It also has either a rapid and sensitive hand feed, or a powerful and slow hand feed, as desired.

Referring to Fig. 2, the machine is suspended by six round rods, three of which are shown at A, A, A, and the various bearings, etc., for the shafts and spindles are supported by fittings attached to these rods.

The drill spindle is driven from the cone D through the bevels at C. B is the spindle, Q being the drill chuck. Moving with the spindle longitudinally, but not rotating with it, are two racks, R, R, into which gear the pinions T (shown dotted) upon the horizontal shaft S. When this shaft is free to be turned, the drill spindle can be moved up or down by the hand-wheel H, which gives the rapid movement to the spindle. As will shortly be explained, the spindle can also be moved by the grooved wheel G, which resembles hand wheel H in form, when a slow, powerful hand feed is desired. The upper end of the spindle passes through the floor from which the drill is suspended.

The power feed is through the cones E, E, thence by belt to the friction wheel F, which runs in frictional contact with the large grooved wheel shown at G. This wheel is loose on the horizontal shaft S and carries two pinions, fast to one spindle, as shown in section at N. Each of these pinions runs in an internal gear, one of which appears at the left of the large wheel at K and the other at the right at L. Of these internal gears, the one at the left is keyed to the shaft and the one at the right is loose on the shaft, but has a series of notches, M, at the rear by which it can be locked in position through a suitable clutch mechanism, not shown. One of the internal gears has a greater number of teeth than the other and hence, when L is locked stationary by the clutch at M, the whole system constitutes a train of epicylic gearing. At P is a lever which operates an eccentric sleeve by which F can be raised or lowered into contact with G. When it is lowered into contact, wheel G carries pinions N in the circumference of a circle about the axis of shaft S and causes the internal gear K to turn slowly, its speed depending upon the relative number of teeth in K and L.

To illustrate the use of the drill, suppose it to be suspended from the ceiling where large castings can be easily moved into position underneath. The spindle is lowered into position by the handwheel H, when the power feed is thrown in by the clutch at M. After having nearly completed the hole, if it be desired to finish by hand, the friction wheel F is moved out of contact and then the spindle will have a powerful hand feed, the operator using the friction wheel G as a handwheel instead of H. After the drill has broken through, the operator throws out the clutch at M and returns the spindle by the wheel H.

There are a number of other interesting machines in this shop that are novel, but as the writer's visit was for only about an hour, time did not permit copious notes and it should be understood that the sketches that have been given illustrate the principle, merely, and not the actual details of construction. Of the other machines, one is a bevel gear planer that was rigged up about 15 years ago to do a special job when the Corliss planer had three months' work ahead. Not caring to wait so long, some parts of old machines lying around the shop were picked up, with which a gear planer was evolved that cost not over 50 dollars all told. The machine answered well enough for the work and at prices charged by others paid at the rate of 60 cents an hour on the first job. Although the machine has since been relegated to the store house, it has occasionally been found serviceable for odd jobs. It is an excellent example of the ability of the true mechanic and engineer to accomplish results, even when the means at hand are not very promising. It affords a lesson that the young mechanic of to-day, who has everything to do with or done for him, may well heed.

* * *

When making calculations, do not retain the fractions or decimals unless the degree of accuracy that their use implies is actually attained.

GEAR SHAPER IMPROVEMENTS.

In the January, 1898, number of MACHINERY was published a detailed description of the Fellows gear shaper which embodied radically new principles for a gear-cutting machine. The teeth of gears are cut in this machine by a planing tool, instead of a milling cutter, and the tool that is used is nothing more nor less than an accurately-formed gear wheel of tool steel, having the sides and faces of the teeth so shaped as to form cutting edges,

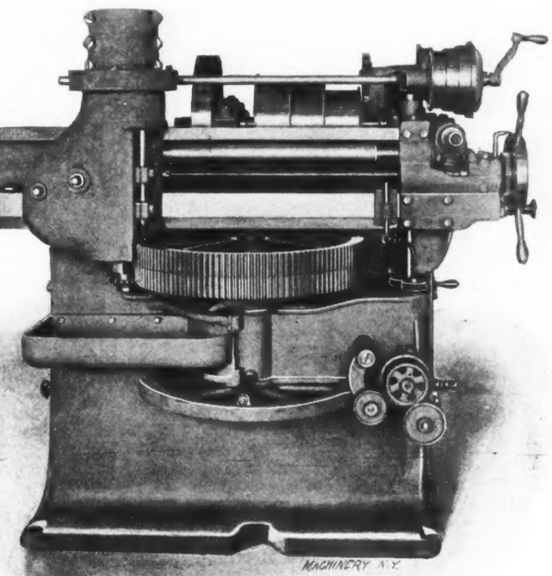


FIG. 1. 36-INCH GEAR SHAPER CUTTING TWO 24-INCH GEARS.

like the edges of a planer tool. This cutter, besides having a reciprocating motion across the face of the gear blank to be cut, revolves in harmony with the blank, just as a gear wheel and pinion would revolve when their teeth are in contact, and correctly-shaped teeth are gradually formed around the whole circumference of the blank. Only one cutter is required for gears of the same pitch of any size, and the principle of the machine is based on the fact that a gear tooth can be made to form its con-

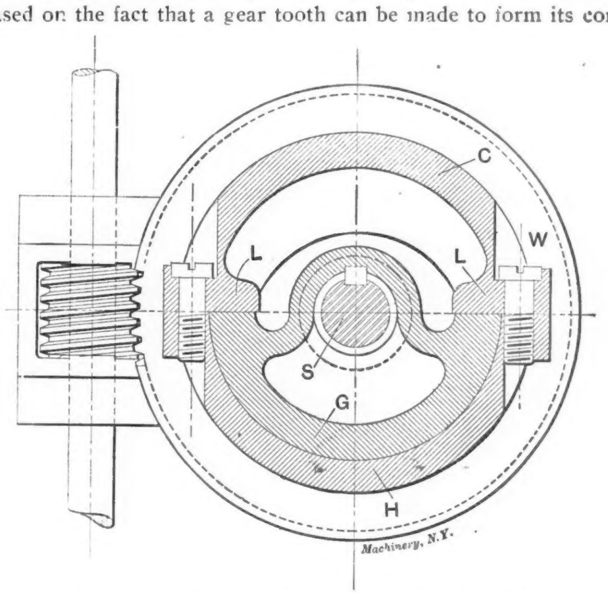


FIG. 2. INDEXING DEVICE FOR CUTTER SPINDLE.

jugate in a blank running in correct relations with the tooth. This is an old principle, but it has been worked out in a very modern way in this machine.

By comparing the illustration of the Fellows gear shaper which we show herewith with that in the number of the paper referred to, it will be observed that several essential changes have been made in the design of the machine, as suggested by the experience gained with the original design during the past two years. It has been desirable to cut coarser pitches than was originally intended and this requires cutters of larger diameter than

were formerly used. To accomplish the heavier work successfully, it is quite essential that the ram carrying the cutter be supported, if possible, the entire length of the stroke. The ordinary design, with overhanging ram, will not do. Also, an ordinary slide, large enough to support the cutter for most of its travel, would be excessively heavy. The problem was finally solved by giving the ram a circular form somewhat larger than the diameter of the largest cutter, allowing the cutter to follow the ram into its guide. Referring to the illustration, it will be seen that there are a pair of gear blanks in position, with the

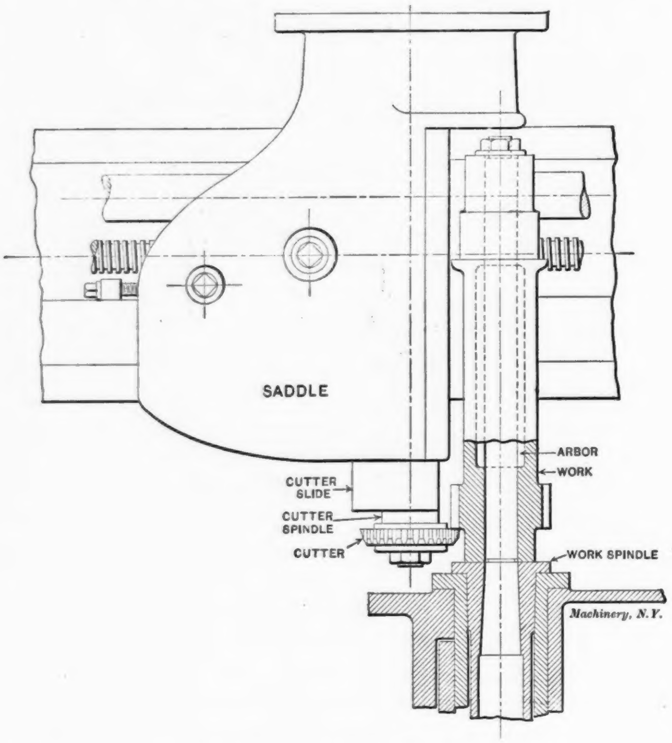


FIG. 3. CUTTING BACK GEAR PINION.

cutter operating upon them. Above these blanks are the ways, or the cross-rail upon which slides the saddle carrying the cutter bar or ram. This ram is vertical and its lower end, with the cutter, can be seen at the left, projecting a short distance below the lower edge of the saddle.

Another improvement that has been made is in the means used to control the cutter spindle. As stated above, both the cutter and the blank must rotate in unison and the cutter in addition has a reciprocating motion in order to cut the teeth. This double motion of the cutter is arranged by attaching the cutter

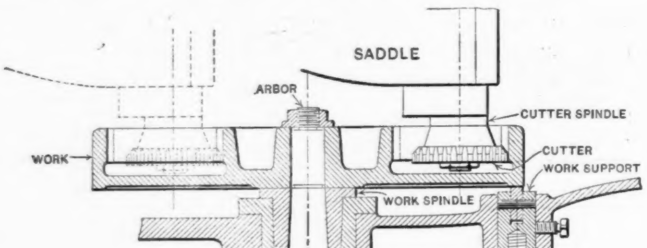


FIG. 4. CUTTING INTERNAL BACK GEAR.

to a spindle which passes vertically through the center of the ram and reciprocates with it, but which is free to turn inside of the ram so as to give the cutter the proper rotary motion. The latter motion is obtained through the medium of a worm and worm-wheel and the improvement consists in arranging the sliding connection between the worm-wheel and the cutter spindle so that there will be no backlash between the two, even after long wear. The way the problem is worked out is shown in Fig. 2. The cutter spindle extends above the cutter ram and a section at this point is shown in this figure. S is the cutter spindle and to it is keyed securely a piece of the shape shown at G, which moves up and down with the spindle. W is the worm-wheel, which has a long hub H extending upward for some distance. One-half of this hub is cut away and to it is bolted a cap, C, which has lugs L, L, extending inward and bearing on two flat surfaces of the guide G. Now, as the worm-wheel revolves, motion is transmitted to the spindle through its hub and the guide G, and, at the same time, the spindle and its guide are free to slide inside of this hub, and the sliding surfaces are at so great a distance from the center of the spindle, and are so well proportioned, that they are very durable. Moreover, after long wear any lost motion can be taken up by means of the cap.

It will be noted from the photograph that the saddle has most of its bearing for the ram on the right side of the cutter, removed to give room to cut pinions with long hubs or quills. Fig. 3 shows the method of cutting the back gear quill of a lathe head and in Fig. 4 is an illustration of a method of cutting internal gears, work for which this machine is particularly adapted. The gear shown is the back-gear used on the Fellows gear shaper, which has an internal and an external gear on one hub. This gear is cut at one setting by the same cutter, the position of the cutter for the external gear being indicated by the dotted lines.

* * *

A FLOATING MACHINE SHOP.

The accompanying illustration is taken from a photograph of a floating machine shop. This shop is not intended to be a rival of the repair shop Vulcan, which as far as we know, is the first and only shop that was designed for exclusive use while afloat. The natural home of the shop shown is upon dry land, and it is merely in the process of transportation from one point to another. It is a section of the shop of H. Bickford, Lakeport, N. H., who make a specialty of the manufacture of boring and turning mills, which are known to many readers of this paper.

MOVING DAY AT LAKEPORT, N. H.

The building is 120x40 feet, and as it was desired to move it, the novel method was adopted of floating it upon barges. Three barges were used with two tug boats, one on each side, and the whole building was moved with everything intact at a cost of less than $500. An account was recently published of the moving of a building upon railroad cars, and Mr. Bickford writes us that he believes that method was no more novel than the one adopted by himself. The photograph for the illustration was kindly furnished by Mr. Bickford, and is reproduced herewith.

* * *

THE LOST FOUND.

"Ice and Refrigeration" says that a Kentucky scientist claims "to have discovered the lost art of tempering copper by means of intense cold." When steel is tempered and hardened it is first heated and softened and then plunged into cold water. This man, however, claims that copper is affected in just the opposite way. When placed in the intense cold and chilled to a temperature of 312 degrees by liquid air, he says that it is softened, and that if it be then withdrawn and thrust into a heated furnace it will be hardened and tempered. And so it seems that the ancients are supposed to have known all about liquid air or some other substance approaching absolute zero temperature! Shades of Tripler, what next?

GAS ENGINE DESIGN.—3.

DIRECTIONS FOR CALCULATING DIMENSIONS AFTER THE MAIN PROPORTIONS HAVE BEEN DETERMINED.

E. W. Roberts.

Having determined the cylinder diameter, the stroke, the volume of the compression space and the speed at which the engine is to run, the designer has a foundation upon which to base the remaining dimensions of the engine. It is well to make the bulk of the computations before starting the drawing, and I will proceed to show the methods for determining the minor dimensions of the engine. Many of these dimensions are based upon the diameter of the cylinder. In fact this method of design is often overdrawn and it will, in some cases, give dimensions quite out of proportion to the requirements of the part. There are, however, quite a number of dimensions that may be based upon the cylinder diameter without leading the designer into serious errors.

A very important matter and one that is quite frequently overlooked by the average gas engine designer is the proportioning of the inlet and the exhaust passages. They are too often made smaller than requisite for the efficient working of the engine. A good rule, and one that is followed by the most successful designers is, to limit the speed of the gases in the inlet passage to 100 feet per second and those in the exhaust passages to 85 feet per second. For illustration take a 10x15 engine running at 220 r. p. m. The piston speed would then be

$$\frac{2 \times 15 \times 220}{12} = 550 \text{ feet per minute.}$$

The area of the piston is 78.54 square inches. At 100 feet per second the speed of the gases in the inlet passages would be 6,000 feet per minute. The areas of the cylinder and the inlet would then be inversely proportional to the speeds of the gases in each. The area of the inlet passage would then be

$$\frac{550}{6{,}000} \times 78.54 = 7.2$$

or a circular passage 3.03 diameter, say a three-inch pipe.

For the exhaust passages the speed would be 5,100 feet per minute, and the area of this passage would be

$$\frac{550}{5{,}100} \times 78.54 = 8.46 \text{ square inches,}$$

or a circular passage 3.2 inches diameter, say a three and one-half inch pipe.

The general formulas for the above calculations would then be

$$\frac{S}{6{,}000} A = a \text{ for the inlet, (9)}$$

$$\frac{S}{5{,}100} A = a^1 \text{ for the exhaust, (10)}$$

Wherein

S = speed of piston in feet per minute.

A = area of cylinder.

a = area of the inlet passages.

a^1 = area of the exhaust passages.

For a speed of 600 feet per minute these formulas resolve themselves into the following:

$.1A = a$ (9a)

$.12A = a^1$ (10a)

As these passages are for the most part of circular cross-section, the latter formulas may be still further modified and based directly upon the diameters of the cylinder and the passages.

Thus

$.316D = d$ (9b)

$.35D = d^1$ (10b)

Wherein

D = the diameter of the cylinder.

d = the diameter of the inlet passages.

d^1 = the diameter of the exhaust passages,

these two formulas being, like the preceding, applicable only when the piston speed of the engine is 600 feet per minute.

It is not always practical to make the valve openings themselves as large as the above formulas call for. Particularly is this true when the valves are placed in the cylinder head of the engine. It is advisable, however, to make them as nearly as possible to the above dimensions and the writer would advise against making them less than 75% of the dimensions indicated by the formulas, otherwise there is apt to be wire drawing, which will show to a marked degree on the indicator diagram.

The thickness of the cylinder walls is dependent not only upon the requirements for resistance to bursting but also those of rigidity, wear and reboring when the cylinder gets out of true. On the basis of 4,000 lbs. safe stress for cast iron and 300 lbs. maximum pressure in the cylinder, the thickness of the wall for resistance to bursting would be .0375 times the diameter of the cylinder for the same safe stress; and on 500 lbs. maximum pressure, the thickness of the walls would be .0625 times the diameter of the cylinder. Practice among gas engine designers gives an average of .09 times the cylinder diameter, a figure which gives ample allowance for all factors. Hence the following formula represents average practice in this respect:

$t = .09D$ (11)

Wherein t = thickness of the cylinder wall.

D = the diameter of the cylinder as before.

Average practice gives for the depth of the water jacket measured on a radius of the cylinder across the water space,

$j = .1D$ (12)

Wherein j = the depth of the water jacket.

For the thickness of the outer wall surrounding the water space, there appears to be no rule which is followed even closely by gas engine designers, and the writer has adopted the following for engines of his own design:

$w = .045D$ (13)

Wherein w = the thickness of the jacket wall.

This latter ratio will be seen to be just one-half of that given for the cylinder wall, a proportion which makes it convenient to remember. For very small engines these formulas give dimensions that are scarcely large enough, and it is well to adopt a minimum thickness for the cylinder wall of 5-16 inch, for the water space ⅜ inch, and for the jacket wall 3-16 inch. Otherwise it will be found difficult to get the best castings.

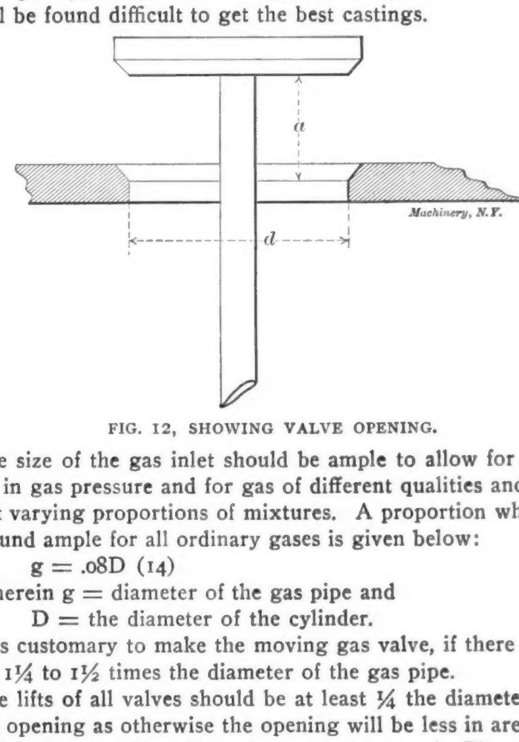


FIG. 12, SHOWING VALVE OPENING.

The size of the gas inlet should be ample to allow for fluctuations in gas pressure and for gas of different qualities and consequent varying proportions of mixtures. A proportion which will be found ample for all ordinary gases is given below:

$g = .08D$ (14)

Wherein g = diameter of the gas pipe and

D = the diameter of the cylinder.

It is customary to make the moving gas valve, if there be one, from 1¼ to 1½ times the diameter of the gas pipe.

The lifts of all valves should be at least ¼ the diameter of the valve opening as otherwise the opening will be less in area in the cylindrical space about the valve as shown at a in Fig. 12. The space for the passage of the gases is a cylindrical surface with a height a and diameter d equal to that of the valve opening. In order to make the area the same as that of the valve opening, a must be of such a height that the area of this surface, which is found by the formula area = π da, shall be equal to the area of the valve opening. And since the area of the valve opening is equal to

$$\frac{\pi d^2}{4}$$

the value of a may be found by equating these two quantities and cancelling, whereby the result becomes

$$a = \frac{d}{4}$$

The diameters of the inlet and the outlet pipes for the jacket water should be made about 15% of the cylinder diameter, taking the pipe which is nearest that given by this rule, and always giving the benefit of the doubt to the next larger size.

There has now been given sufficient data for the design of the cylinder, an example of which is shown in Fig. 13. It is customary to build cylinders for all engines except the very smallest —six horse power and below—separate from the frame of the engine. The style of cylinder shown in the figure is that employed on vertical engines and it is bolted to the frame by means of the flange as shown. This flange may be made square or circular according to the fancy of the designer, the square form shown in the figure being better adapted to an oblong frame such as is employed for two or more cylinders. The writer has taken as an example a cylinder for a 12"x18" engine. Suppose that the pressure which it is desired to obtain after compression is 80 lbs. per square inch, and that the entire clearance is included in the cylinder by so designing the engine that the valves are contained in the cylinder-head and open directly into the cylinder. The absolute pressure will then be $80 + 14.7 = 94.7$ lbs. after compression, and the clearance is found by means of formula (1). Taking the total volume of the cylinder as equal to one, for the sake of convenience, and finding the volume of the compression space as a per cent. of the whole $D = 94.7$ and $K = 14.7$ and V is equal to

$$\sqrt[1.3]{\frac{14.7}{94.7}}$$

In order to solve this equation it is necessary to resort to logarithms as already shown. First finding the logarithm of the fraction.

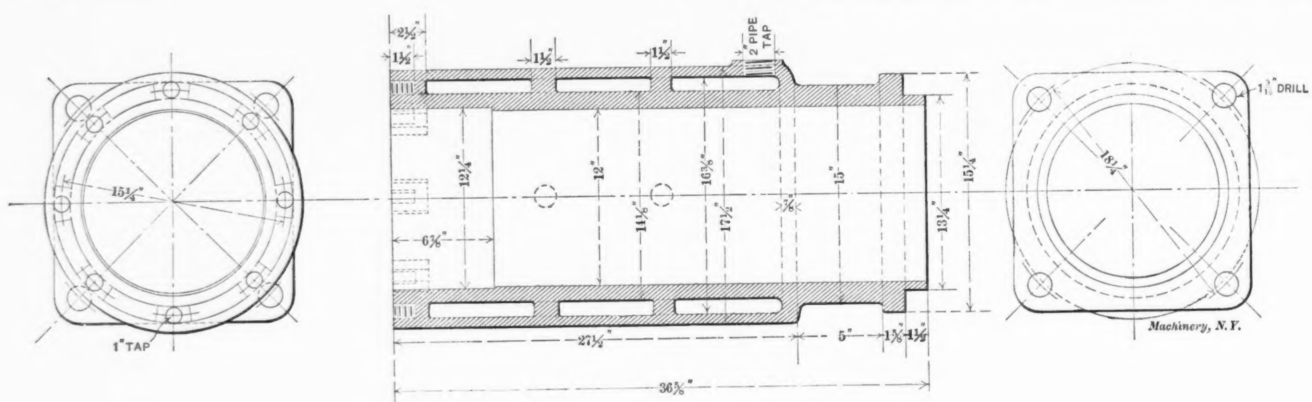


FIG. 13, SHOWING DIAMETER OF GAS ENGINE CYLINDER.

Log. 14.7 = 1.167317
Log. 94.7 = 1.976350
1.190967 Subtracting
1.3).809033 Subtracting from 1.
.622333
1.377667 Subtracting from 1.

This last logarithm is that of the compression space, remembering that the total cylinder volume has been taken as 1. The number corresponding to this logarithm is a little less than .2382 Three figures are all that it is necessary to employ and the quantity taken will be .238. The compression space should then be 23.8% of the total cylinder volume. The volume swept over by the piston would then be 100% — 23.8% or 76.2% of the total cylinder volume. If the added diameter given to the compression space by the counter-bore be not considered, the length of the cylinder required for the compression space would be $23.8 \div 76.2 = 31.3\%$ of the piston displacement. The length of the compression space would then be $18 \times .313 = 5.634$ or 5⅝ long.*

Should it be desired to carry this computation to the refinement of allowing for the counter-bore, it will be necessary to find the volume displaced by the piston. This volume is

$(12)^2 \times .7854 \times 18 = 2030$ cu. in.

$2030 \times .313 = 640$ cu. in. volume of compression space.

The area of the compression space, allowing ¼ inch for counterboring, is

$(12.25)^2 \times .7854 = 118$ sq. in.

$640 \div 118 = 5.45$ say 5½ inches.

The length of the compression space is thus shown to be ⅛ less than that found by the approximate method. The piston should extend far enough into the counter-bore to allow, on an engine of this size, about ¼ inch over travel of the piston.

The sizes of the cylinder-head studs should be calculated for a pressure at least sixty pounds above the usual maximum pressure in the cylinder, to allow for sudden strains which are occasionally thrown upon the engine by very rich mixtures. The maximum pressure at the beginning of the expansion stroke is the compression pressure multiplied by 4 or $80 \times 4 = 320$ lbs. Adding 60 lbs. to this amount, the pressure upon which to base the calculations of the studs is 380 lbs. and the total pressure is the latter amount multiplied by the area of the counter-bore or $380 \times 118 = 45{,}000$ lbs. Dividing this among eight studs, the tension upon each stud would be $45{,}000 \div 8 = 5{,}650$ lbs., and allowing a tension of 10,000 lbs. per square inch as a safe stress for mild steel, the area of each stud should be $5{,}650 \div 10{,}000 = .565$ square inches at the root of the thread. The corresponding diameter is .85 inches, and from a table of screw threads it will be found that the stud having a diameter next larger than .85 is 1⅛, but that the 1 inch has a diameter at the root of .837 or within a little over 1% of the required size. The 1 inch stud will therefore be used.

In regard to the number of studs, it is usual to have no less than six, and a good rule to follow is to use enough so that they will not be over six inches apart. In the case of the cylinder under consideration, six studs would have placed them too far apart. The stud circle should be placed at the center of the water-jacket and this will give the diameter of the stud circle as 14⅛ + 1⅛ = 15¼. The circumference of the circle is 47.9 inches and eight studs brings the distance apart just within the limit.

The thickness of the cylinder wall, the depth of the jacket and the thickness of the jacket wall are calculated by the formulas given above and are as follows:

Cylinder wall (formula 11) = $12 \times .09 = 1.08$, say 1 1-6 inches.

Depth of jacket (formula 12) = $12 \times .1 = 1.2$, say 1⅛ inches.

Thickness of jacket wall (formula 13) = $12 \times .045 = .54$ inches, say 9-16 inches.

The four bolts which are used to bolt the cylinder to the frame are subject to the same tensile stress as the cylinder studs. The strain on each bolt is therefore $45{,}000 \div 4 = 11{,}250$. The bolts may be made of mild steel and the area of each would therefore be 1.125 square inches and the diameter at the root of the thread should be 1.2 inches. The table shows that the bolt required is 1½ inches, the 1⅜ inch bolt being a little too small. The thickness of the flange should be equal to, or slightly greater than, the diameter of the bolt. In the present instance it is made 1⅝ inches thick.

The length of the projection below the flange for centering the cylinder in the frame should be about ⅛ the diameter of the cylinder and is 1½ inches in this case. The total length of the cylinder is the sum of the following distances:

Projection of the piston head into the cylinder, 1 inch.
Length of the compression space, 5½ inches.
Stroke of the engine, 18 inches.
Length of the piston minus the over-run, 12 inches.
Total length of cylinder, 36½ inches.

* In the above, and in all future calculations in this series, the writer will employ the slide rule. Hence any slight discrepancies discovered will be due to the limitations of that instrument.

The piston should be 1 1-3 times as long as the diameter and ¼ of its length may be allowed to over-run the cylinder at the end of the forward stroke.

The water-jacket should extend about 10% of the stroke beyond the end of the piston when the crank is at the outward dead center. In this cylinder the jacket is allowed to extend 2 inches beyond the end of the piston travel. The length is therefore 26½ inches from the end of the cylinder. Other dimensions of the cylinder are shown in the figure.

The size of the water inlet is obtained from the rule already given. It is $12 \times .15 = 1.8$, say 2" pipe. It should be placed so that the bottom of the pipe is as near as practical to the bottom of the jacket.

* * *

JONES ENGINEERING CO., LIMITED.

CHAPTER 6.—MR. JONES TRIES TO BABBITT AN ENGINE BEARING.

You know that a good handle is a rather difficult job to turn up and get a pattern which will look well and feel well; and having made one, it is quite difficult to turn another exactly like it; indeed, it is sometimes given to a new man as a test job, and in fact it was Jones' favorite test. He tried it on a young man who started in to work the other day, telling him to turn up such a handle as he would think suitable for a machine which was under way. The young fellow did a fairly good job, but he displayed it with such a superior air that the old man thought it necessary to give him a little lesson, "lest he forget," as Kipling would say. He examined the handle carefully and finally directed him to make another just the same length, but a little bit larger, and in order to show him the proportions of a perfect handle, Jones set the calipers himself. On comparing these with the handle which he had just finished, the new hand discovered that the "little bit larger" was only 1-16 of an inch, and he concluded that no man, let alone Jones, could be so discriminating as to judge, by the unaided eye, within this limit; so instead of making a new handle to match the calipers, he closed up the calipers to match the old handle and passed them both in for inspection. "There," said the boss, "that's better; that's about right; don't you think yourself that it's a great improvement?"

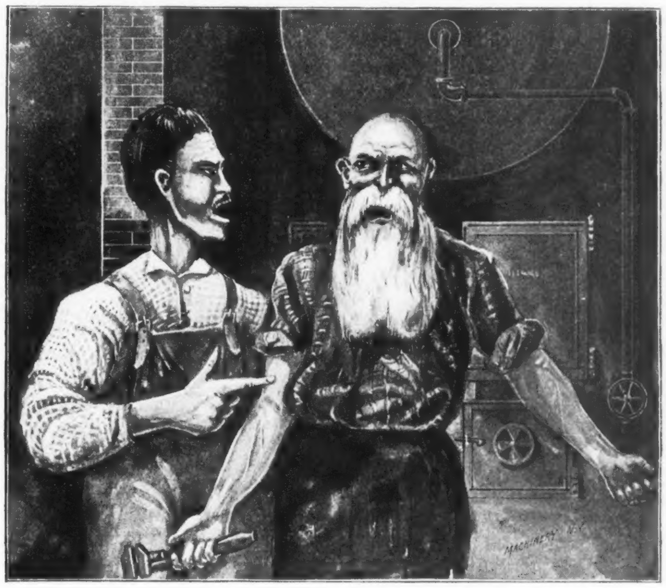
Now, if the smart young Aleck had said "yes" he would have been all right, but he tried to turn the laugh on Jones by giving the whole job away, thinking that the old man would join in and laugh with the rest. He was mistaken; if any laughing was to be done the young chap must do it himself. "Here, you, I'll teach you to make fun of me to my face; now you take these calipers and calip every durn handle in this shop and you just keep caliping until I tell you to quit." The young man argued that he wasn't hired to be snubbed like that. "Yes, you be, you're hired to do as I tell you, and you be a doin' of it." The young man started in with what grace he could, trying his calipers on everything within reach, the old man watching him out of the corner of his eye until he was called away, as you will presently be told. The young man, concluding that he had all the fun he wanted, put on his coat and started off "down country" after another job.

Across the river from Jones was a mill where he was often called to conduct repairs. One afternoon he heard some one shouting to him from over "yonder," so he rushed to the back door and heard the engineer calling out: "Hullo-o-o Jones, put on your boots and come o-o-over here!" As the fellow seemed to be in trouble, Jones lost no time in getting there. He found that while the engineer and fireman had been fishing for suckers in the river, the belt had come off the regulator, allowing the engine to race to beat Nancy Hanks. Now, according to all precedent, the fly-wheel should have exploded and killed some inoffensive person and finally have been picked up in the next county, but it did nothing of the sort. It ran faster and faster until the bearings became dry and the shaft became polished as though it was buffed and finally the babbitt melted and ran down on the floor. When Jones arrived he found the engineer rigging up a chain hoist to take the shaft out from the boxes. He had "been there before," but Jones assured him that there was no need of taking it down, he could do the babbitting with the shaft in place.

"Hadn't the babbitt ought to be hammered and bored out," asked the engineer.

"No, I've got some babbitt that an agent sold me the last time he was round, said it was already hammered and as for boring out, if we leave the shaft right in there and pour the babbitt around it we shall get a better bearing than any boring out would give."

So Jones went back after his "Pre-hammered Babbitt Metal," which the crafty agent had sold him at a dollar a pound, but which looked to others like a lot of old lead. He melted the metal carefully and poured it into the bearings, using plenty of "rosum" to make it flow freely and fill well. It did both, it flowed freely and it filled the cavity, apparently, in good shape. The engineer and fireman looked on with some interest. If the operation was successful they were learning something; if not, they had an unpleasant all night's job in prospect to take the shaft out and babbit the boxes in the orthodox way. After the



"KNOCK SOME INTELLIGENCE INTO YOUR HEAD, MR. JONES."

melted metal had set and a few pails of water had been poured over the boxes to reduce the expansion of the shaft due to the heat, Jones picked up his ladles and directed the engineer "to start her up, easy at first." The steam was turned on, but nothing started; a little more steam was given, but she did not move.

"You must have stopped her right on the dead center," said Jones.

"Didn't either—see for yourself."

"Then you must have let the pressure go down, guess you have been fishing for suckers again."

"There's pressure enough, same as usual," said the engineer, who had become somewhat distrustful of the operation.

"Throw off your main belt, probably every machine in the shop is shipped on and you can't expect to start them all at once."

"You needn't trouble yourself to throw off any of our belts, we have always been able to start with them on."

"Take a hammer and rap on the boxes, guess they jest stick a little 'cause they are new."

"Take a hammer and knock some intelligence into your head, Mr. Jones. The trouble is you have gone and soldered the shaft to the boxes with your patent babbitt and your rosin and your dum foolishness and I'd like to know what you are going to do about it."

Well, there was nothing that could be done about it; the shaft had become so heated and run so dry that not a particle of oil remained upon it, and the babbitt metal, aided, perhaps, by the rosin, had clung to it so firmly as to hold it in place. Just how they ever got it free I can only guess, but it was without the help of our friend, Jones, who returned to his shop with drooping spirits. The story soon got around and everybody was soon laughing at his numerous "bulls," until he finally sold his shop and left town. He, too, wandered off "down country," and going into a shop in search of employment, the first person whom he saw was the young man who had turned the handle in Jones' old shop.

"Hullo, Aleck," said Jones. "What be you doin' here."

"Calipering handles," said the young man with a grin, holding up a pair of calipers. "You told me to keep at it until you ordered me to quit."

W. H. S.

BUSHING A LOCOMOTIVE CYLINDER.

Owing to the generally unfavorable conditions under which a locomotive performs its work, the wear and tear of all parts of the machinery is much greater than on the mechanism of a stationary engine for the same length of time. This statement is particularly true of the valves and cylinders. The dust and cinders drawn into the cylinder cocks when "drifting" and the often insufficient lubrication of these parts which follows the narrow-minded policy in the management of many railroads, demanding a maximum of mileage for a minimum of oil consumption, causes the cylinders to wear rapidly, and they frequently require reboring with a mileage of 150,000 miles or less. It therefore follows that a few years of service finds a locomotive over-cylindered or with cylinder diameters bored out to such a diameter that the tractive force of the locomotive due to its weight is not sufficient to balance the pressure on the pistons and excessive slipping follows when such an engine is starting a train. Besides this trouble, there is also the danger of rupture from the internal pressure on the walls of the cylinders which have become excessively thin from the wear and frequent re-borings.

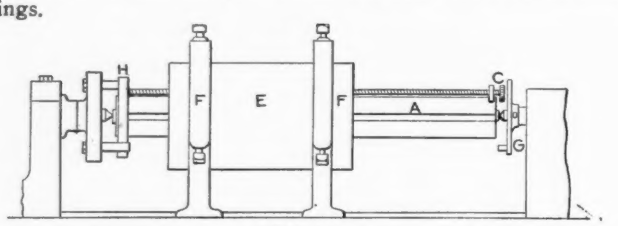


FIG. I

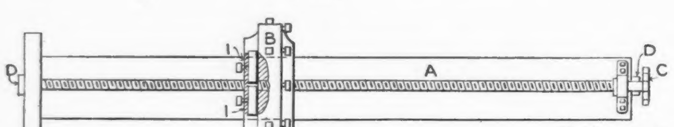


FIG. 2

When this condition of the cylinders of a locomotive has been reached, it is quite common practice in many locomotive repair shops to bush the cylinders, or, in other words, to insert a thin liner in them which reduces the diameter to the normal size and gives them a new lease of life. Although the operation of bushing a locomotive cylinder is simple, it is, however, interesting and will bear a general description, as there are some kinks in the operation that are the result of practical experience.

The casting that is to be a cylinder bushing is made in the form of a hollow cylinder having a wall thickness of about 1½" for a 20" cylinder and a length of perhaps 4" greater than that required between the heads. The cylinder is bored out for the bushing before the latter is turned and the bushing is generally bored before being turned. The boring is usually accomplished in the smaller repair shops on a lathe rigged for the purpose. Fig. 1 shows the general arrangement of a lathe for this work which was used in the Fallbrook Railway shops at Corning, N. Y., and the following described operation is the one followed in this shop. As will be noted, the bushing E is held in two huge steady-rests or chucks F F, which in this instance were provided with three adjusting screws each, for holding and centering the bushing with the axis of the lathe. The boring-bar used for boring bushings and new cylinders is shown in Fig. 2, which shows the cast-iron bar at A to which is splined the boring-head with multiple cutters at B. The feed-screw with its star-wheel is shown at C and the split nut for the feed-screw at I I. The bar A was made, as stated, of cast-iron which gives great stiffness, and it was provided with steel centers D D which gave better wearing results than would have been obtained from the cast iron bar with plain centers. After the bushing was bored, the ends were beveled out with a cutter in the boring head so that the bushing would center itself accurately on the mandrel shown in Fig. 3. This mandrel, as will be seen from a glance at the cut, has two tapered parts A A which are split at one side and provided with a clamp screw across the division line so that the two cones can be firmly gripped to the bar B. In addition the bar B is provided with a keyway in which feathers in the parts A A engage. The nut at C is for forcing the right cone to the left and thus clamping the bushing between the two opposing cones. To drive the bushing when turning it down to the proper diameter, it was found best to drill and tap a hole in the bushing for a stud H Fig. 4, and drive from that point instead of attempting to drive from the mandrel, as when this was done it was necessary to clamp the bushing so tightly that it was likely to be sprung out of shape and even when clamped as securely as possible would sometimes slip and cause trouble.

After the bushing was turned to the proper size, which must be enough larger than the diameter of the cylinder to give it a shrink fit, it was cut nearly, but not quite in two, with a parting tool, as shown at Fig. 4, and then the ports were drilled and chipped out so that they would correspond to those already in the cylinder. When boring the cylinder a shoulder is left near the back head against which the bushing will abut when in position, and when cutting off the bushing in the lathe it is left long enough to project slightly from the face of the joint so that it can be finished down flush when shrunk in place. When the bushing is ready for insertion, the cylinder is heated to expand its diameter to a size sufficient to admit the bushing freely and to do this without danger of getting caught, it is usually warmed up enough to enlarge the diameter from 1-32" to 1-16" greater than that of the bushing. This is necessary on account of the rapid cooling of the cylinder with a consequent reduction of its diameter and an accompanying heating of the bushing and consequent increase in its diameter. So it is evident that any little delay at a critical point may result in a very awkward predicament and one not well calculated to increase the prestige of a machinist who is so unfortunate as to become "stuck" when engineering such a job. The cylinder is sometimes warmed to the required temperature by a light wood fire built in the bore, but as this makes a dirty job and requires the most scrupulous nicety in cleaning out the debris after the heat is taken and at a time when moments are precious, the Bunsen gas burner shown in Fig. 5 can be made and used with great success, as it requires so little gas for the heating of a cylinder that the cost is trivial, and being perfectly clean in its action no time is lost in cleaning out any debris after the removal of the heater.

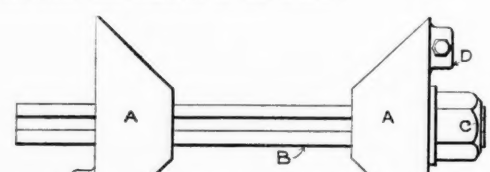


FIG. 3

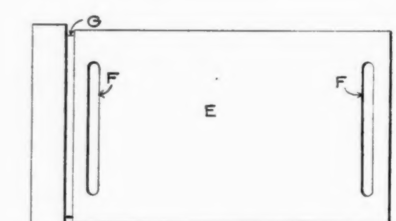


FIG. 4

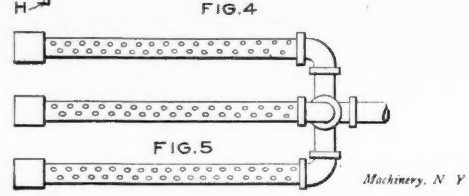


FIG. 5

To facilitate the insertion of the bushing, its surface is well smeared with a coating of white lead and oil which acts as a lubricant while entering it and afterwards fills up the interstices between the bore of the cylinder and the bushing so that any leakage will be effectually shut off. When putting the bushing into the cylinder, the ring that projects and which is nearly cut off, is found to be very convenient and necessary for obtaining the proper location of the bushing so that the ports shall register with those in the cylinder. By slipping a monkey-wrench on to the projecting part, the bushing can be readily turned to its proper position, which would be a rather awkward proceeding to accomplish without a projecting part. After the bushing is in place, it is drawn firmly against the shoulder at the further end by a long bolt and cross pieces across the mouth of the bushing, and by leaving it under these conditions until cool, the bushing cannot draw away from its abutment at the farther

end. After the now unnecessary ring is knocked off and the end finished off flush with the cylinder, the job is complete providing the lathesman has counterbored the bushing to the correct dimensions. If this has been neglected, it must be done when the boring bar is in position for facing off the joint.

In some quarters, the bushing of locomotive cylinders has fallen from favor not because it is not a good mechanical expedient, but from the fact that it is often necessary to reduce the cylinder diameter slightly below the nominal diameter in order to use a bushing having walls thick enough to be of any practical value. This occurs only on locomotives having cylinders with thin walls to begin with, but the "kick" that comes from the freight engineers when a locomotive gets new tires and has the cylinders bushed in such cases, is one that does not increase the master mechanic's peace of mind. With an increased driver diameter and a reduced piston area, the starting power of a locomotive may be greatly reduced, and, although possibly far more economical in fuel and water consumption, the practical disadvantages overbalance any gains that may result from economy or cheapness of general repairs. It has in consequence been found to be better though more expensive practice under these conditions to replace worn cylinders with new ones of full diameter than to bush old ones down to a slightly smaller size.

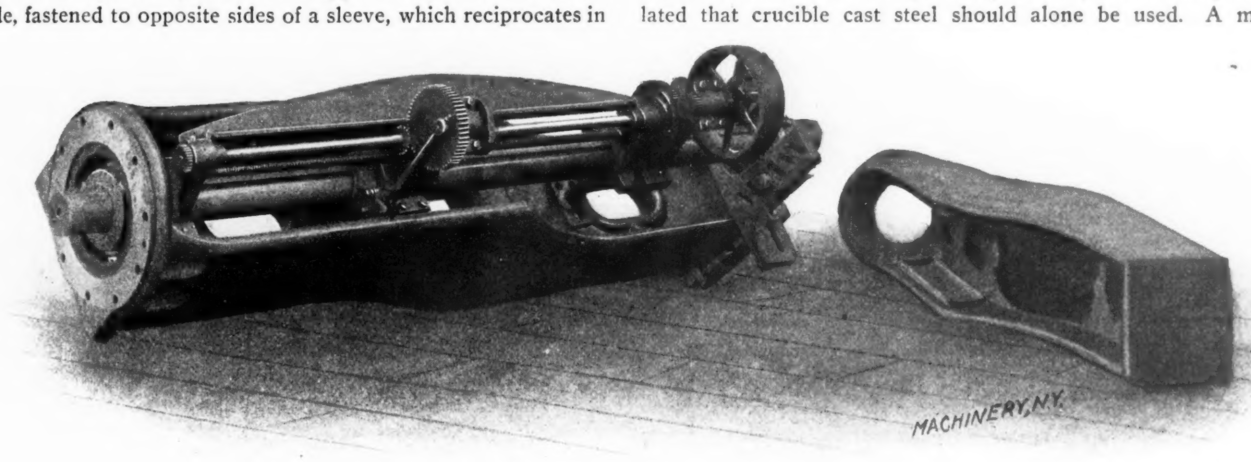
* * *

BORING RIG FOR ENGINE FRAMES.

CHARLES FOSDICK.

This cut shows a very effective device for boring the guides for cross-head shoes upon a girder engine frame. The centering bar is held by a "cat-head" at the cylinder end of the casting and by a U-angle iron and step at the off-set end and remains in place until the machining of the casting is fully accomplished, with the exception of the drilling. The bar has centers in its ends for use in the lathe and is used as an arbor to face both ends of the casting.

After the facing is completed and before removing the arbor or bar from the casting, the boring head is attached. This head is constructed in halves to clamp around the bar, and while it produces what may rightly be called "bored guides," it is in reality a "planing head" rather than a "boring head." There are two cutters, one for the upper and one for the lower guide, fastened to opposite sides of a sleeve, which reciprocates in the arc of a circle about the axis of the bar. This sleeve, instead of having its bearing directly on the bar, bears on another sleeve which is feathered to a slot in the bar so that it can slide but not turn upon it, and thus the wear upon the bar is reduced to that of the mere sliding of this bushing upon the bar as the cutter head advances.



BORING RIG FOR ENGINE FRAMES. SHOWN IN POSITION.

Reciprocation of the cutter head rather than rotation is desired in order that the central rib of the engine frame may be as near the center line of the guides as possible, thus increasing the stiffness of the guides. Only enough clearance for the passage of the crosshead is allowed.

As stated, the cutter head is provided with two cutting tools, one for each guide surface. These tools are made adjustable for boring the right diameter and are readily set by calipering from the cut to the bar surface. The reciprocation of the cutter head is obtained by a short connecting rod between a pin on the cutter head and a pin in the face of the driver. This driver has a gear-tooth rim and is carried in a bearing on the standard which forms the sleeve for the cutter head to move upon and which, as we have before said, moves forward as the cut advances. This driver engages with a pinion feathered to a shaft, plainly shown in the engraving, the pinion being carried forward with the cut by the standard, which also makes a central support for the shaft. At one end of the shaft is a gear which again engages with a pinion on one end of a short shaft, which carries at its other end a belt driver pulley as shown. By this back-gearing a powerful cutting force is given to the cutters and roughing out is done quickly and easily. The feed or forward motion of the standard and cutter head is obtained by a threaded feed rod lying so as to just clear the cutter head. This rod has a ratchet wheel feathered to it, which is connected to a nut in the standard.

The ratchet is operated by an eccentric and strap on the back side of the driver gear. By changing the position of the pin in the driver gear the stroke of the cutting tools can be set to agree with the diameter of the surface of the guides and the width of the guide faces.

This boring and facing rig forms a stiff arrangement, and as the work of facing the frame and boring the guides is done at one setting of the bar, the work should come true. It is another of the practical devices which are so common in American shops for accomplishing simply and correctly a needed result. This tool has been used for many years by the Fitchburg Steam Engine Co. in their shops at Fitchburg, Mass.

* * *

In view of the discussion among engineers as to the material and design for the cables for the new Brooklyn bridge it is interesting to recall that Col. Roebling, the chief engineer of the bridge, decided, after nearly six years of experimenting with steel wire of foreign as well as American production, that neither open hearth nor Bessemer steel could be made which would come up to the requirements he thought it necessary to demand for the cable wire. As originally drawn his specifications excluded steel made by these processes, and carefully stipulated that crucible cast steel should alone be used. A more mature consideration of this stipulation when the subject came up for final discussion before the Board, however, reversed his opinion. At the present time the cheaper grades of steel have been so perfected that there is no doubt as to their quality.

* * *

A good scheme to follow in cross-sectioning tracings is described by a writer in the "Mechanic Arts Magazine" who says that he never sections the original drawing accurately but merely indicates the sectioning roughly. After the tracing is ready for sectioning, he slips a piece of cross-section paper which is ruled about 1-16" apart, under the tracing paper and traces the required sectioning. If the sectioning is to be fine, every line is traced; but if coarse, only alternate lines are traced, or every third line for very coarse work.

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FEBRUARY, 1900.

CIRCULATION STATEMENT.

The regular edition of Machinery for February is 20,500 copies, American Machinery is the title of the foreign edition, printed on thin paper and comprising all the reading and advertising matter in the domestic edition. No subscriber is entered on our mailing list until his subscription is paid for, and all subscriptions are stopped at expiration. No papers are sent free except to advertisers, exchanges and circulation agents.

The circulation of the three leading papers in the machinery trade, so far as it is possible to obtain the figures, is as follows:

The Iron Age, about	7,000
The American Machinist, about	12,000
Machinery	20,500

A prominent manufacturer of machine tools in Great Britain expresses the opinion that the present period of unexampled world-wide business activity is rather unfavorable to the forming of an opinion as to the ultimate results of American competition as regards machine tools and engineering in general, as users are at present in many cases glad to supply their requirements from any respectable source, and the former prompt delivery of American tools is not now to be relied upon. He considers the real tug of war will come when things quiet down to a normal level, but as that time seems, as yet, far distant, such changes may in the meantime be brought about on both sides the Atlantic, which may materially alter the present complexion of affairs.

* * *

GIVING VS. WITHHOLDING INFORMATION.

When a manufacturer buys a machine, he almost invariably does so upon the advice of some person connected with his firm who is acquainted with shop methods and is competent to render an opinion as to its merits. Before expressing a preference for any particular machine, such a man wants to know about its details of construction and he will make it a point to find out about these, by some method or other, if he can. If, in addition, he knows something about the methods and care used in its manufacture, and is favorably impressed with them, the more likely will he be to recommend the machine, other things being equal.

One of the most important objects of a technical paper is to publish just the kind of information that a man in this position, who is responsible for the purchase of machinery, desires to obtain. Such information is valuable alike to the mechanic, who is interested in all that is new in machine construction, to the manufacturer who wishes to disseminate knowledge about his products and to the buyer who is anxious to learn as much as possible about that for which he is to spend his money.

In attempting to gather this information, however, one meets with views, concerning the advantages or disadvantages to the manufacturer of allowing information to go out for publication, that are as different as black is from white. Some firms, who are building modern machinery by modern methods, object very strongly to the publication of matter that they say will be for the benefit of their competitors and the point is raised that the development of their methods has cost them both time and money and they believe they are better entitled to the results of this experience than any one else.

On the other hand, other modern firms, who are building just as good machinery as those first mentioned, and by just as good methods, court the utmost publicity through the press and give every opportunity, not only to illustrate details of the machinery that they are building, but to describe the methods by which their products are turned out. They, in their turn, state that they consider the publication of such information as an excellent educator for the public with regard to the work they are doing, and that the more interesting such information is made and the more complete it is, the better the advertisement for them.

Here, then, as in many other departments of life and work, we have two contrary views, emanating from similar sources and both given as the judgment of men who base their judgment on years of experience. Both opinions cannot be right and without attempting to decide how great an element of error there may be in either or both, it can be said with justice, that, as far as we are able to determine, those who adopt what we may call the "open" policy are just as successful as those who do not. If the open policy is actually detrimental, it evidently does not seriously handicap the firms who have adopted it.

That many concerns are greatly annoyed by their competitors copying their products, we are well aware. This thieving is not only continually in progress here at home, but abroad as well, and it is likely to increase among foreign builders in their efforts to meet American competition. The copying is done, however, not from newspaper articles, but from the machines themselves. If a firm determines to copy the machine of another, a machine will be bought in the open market, or at least examined, opportunity for which is offered as soon as the machine is placed on sale.

Trouble from copying comes mainly from reproducing features of machines that are regularly manufactured rather than from the adoption of their methods of manufacture. There are too many good mechanics employed in the different shops, and too many tools of all descriptions for turning out all kinds of work, to make it worth while to attempt to copy methods, except, possibly, in some few or unusual instances.

Our advice is to give just as much information to the public about the construction of machinery as it is felt can be given without absolute injury to the business of the manufacturer. This supposed injury should be brought down to a dollar and cent basis—the same basis by which any department of business is estimated—and if it is believed that an injury will be realized that will show itself in decreased profits, there is nothing more to be said. Often times, however, we are suspicious that the injury may be more imaginary than real and that the real change in profits comes in the way of an increase to him who adopts the "open" policy.

* * *

While the making of small tools is not profitable when their cost is compared with the regularly manufactured lines, there are not many machinists but have a few tools of their own make and the apprentice who does not early evince a disposition to make some tools for himself, is not usually adapted to his chosen vocation.

TESTING THE STRENGTH OF MATERIALS—1.

TENSION AND TRANSVERSE TESTS.

EDW. F. MILLER.

The different mechanical tests commonly applied to determine the strength and elasticity of the materials used in construction are the following: Tension tests, compression tests, transverse tests, torsion tests, impact tests and repeated stress tests. A specimen may be subjected to one or more of these tests. As tension tests are the most common, this class of testing will be considered first.

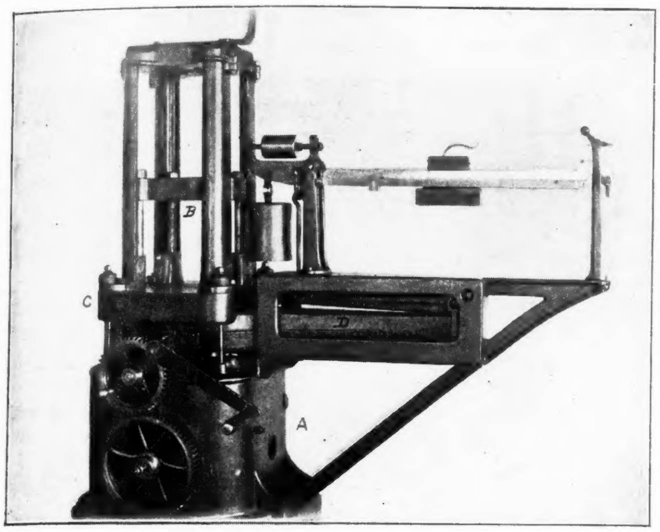


FIG. I. OLSEN TESTING MACHINE.

A simple lever testing machine is shown by Fig. 1. It consists of a hollow base A, in which a number of bevel gears are connected so as to turn four spur gears which act as nuts on four splined screws. These screws pass up through the platform of the machine and fasten to the pulling head B. Outside of these screws there are four cast-iron uprights fastened to the platform but entirely free of the screws. These uprights hold at the top a casting similar to that fastened to the four pulling screws. The platform C rests on four knife edges fastened in two cast-iron levers marked D. The fixed fulcrum of these levers is carried on the top of the casting A which forms the base. The outer ends of these two levers rest on a knife edge hung from a second lever which in turn connects with the scale weighed on the scale beam. To measure the amount the specimen stretches, two clamps, as shown by Fig. 2,* are fastened to the piece of boiler plate 8″ apart. A micrometer having a prick punch mark in one end and an extension piece screwed into the other end is used to measure the extension on two opposite sides of the specimen. As the stretch will be determined by the difference of readings, it is of no importance if the two sides of the clamps holding the measuring points are not exactly the same distance apart.

Suppose that 500 pounds load is put on the specimen and the readings of the micrometer for the two sides are noted; similarly 4,500 and so on, as shown by the logsheet of the test which follows:

TENSION TEST.

No. ...... Date, Nov. 1, '99.
Specimen, Steel Boiler Plate.

LOADS.		MICROMETER READINGS.		Mean of Columns 3 and 4.	Difference of Means.	Stretch of Specimen per inch.	Stretch per inch per 500 lbs. Load.
Actual.	Per sq. in.	North Side.	South Side.				
1	2	3	4	5	6	7	8
0	......	.3402	.3114	.3258	. ...	......	......
500	1000	.3404	.3116	.3260	.0002	.00003	.00003
4500	9000	.3425	.3137	.3281	.0021	.00026	.00003
8500	17000	.3447	.3159	.3303	.0022	.00027	.00003
12500	25000	.3468	.3180	.3324	.0021	,00026	.00003
14500	29000	.3480	.3190	.3335	.0011	.00014	.00003
15000	30000	.3482	.3192	.3337	.0002	.00003	.00003
15500	31000	.3485	.3195	.3340	.0003	.00004	.00004
16000	32000	.3489	.3197	.3343	.0003	.00004	.00004
16500	33000	.3492	.3200	.3346	.0003	.00004	.00004
17000	34000	.3497	.3205	.3351	.0005	.00006	.00006
17500	35000	.3506	.3214	.3360	.0009	.00011	.00011
18000	36000	.3520	.3228	.3374	.0014	.00017	.00017
28500	57000	Maximum	load on	specimen.			

Length between clamps..................	8″
Dimension of cross section...............	1.3333×.3750″
Elastic limit	16,500″
Maximum load	28,500″
Dimensions of fractured section..........	.95×.20″
Ultimate extension in 8 inches............	2.24″
Elastic elongation for 12,000 lbs. load equals	.0064″
Area of original section; sq. ins...........	.5000″
Elastic limit; lbs. per sq. in...............	33,000″
Maximum load; lbs. per sq. in. orig. sect..	57,000″
Area of fractured sect.; sq. in............	.1900″
Reduction of area of cross sect.; per cent.	62.0″
Ultimate extension; per cent. of 8 in......	28.0″
Modulus of elasticity	30,000,000″

Column 8 of the log sheet gives the stretch per inch for each 500 lbs. increase of load. The amount or rate of this stretch is nearly constant till the interval is reached between 16,500 and 17,000 lbs. load, when the rate of stretch for 500 lbs. suddenly

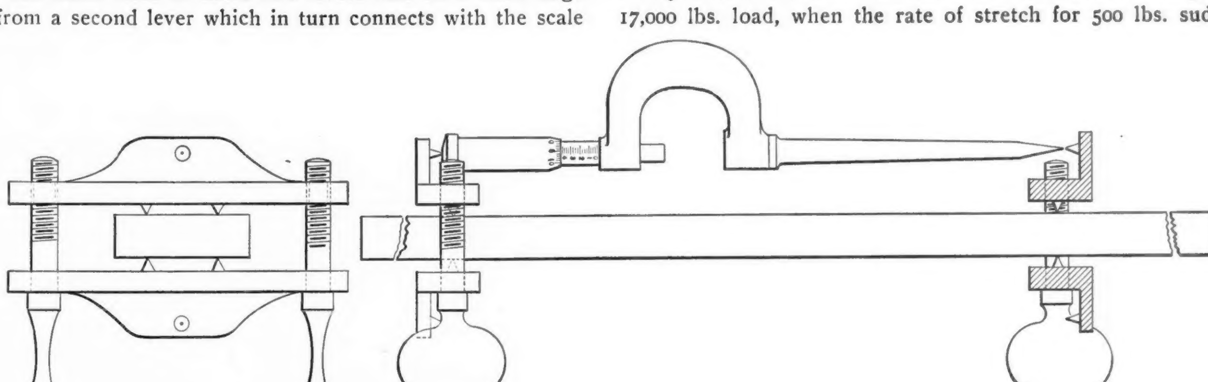


FIG. 2. CLAMPS AND MICROMETER FOR MEASURING STRETCH.

beam where the load is weighed. The lever system and scales are practically the same as in the common form of platform scales used by grocers. Each of the castings, fastened one to the screws and the other to the uprights, has a rectangular hole through the center. The narrow sides of this hole are inclined about ½ an inch in a length of 4 inches. Two wedges of hardened cast steel fit into this opening. The wedges are roughened on their inner faces in order to grip the specimen.

Let us suppose that a piece of steel boiler plate 1.3333″ wide, .3750″ thick and 18″ long is put into the machine and gripped by the wedges. On turning the hand wheel E so as to draw the screws down, a load is put on the specimen. The load on the specimen produces an equal downward load on the uprights which, in turn, carry the load to the platform where it may be

increases and continues to increase with the succeeding loads. The load per square inch at which the rate of stretch first changes is called the elastic limit. In this case, the load on the scale beam at the beginning of the change was 16,500 lbs., and as the area of the cross section of the specimen is 1.3333×.3750=.5000 square inches, the elastic limit is 33,000 lbs. per square inch. If the amounts of total stretch were plotted graphically we should get a line like Fig. 3 called the stretch diagram. The point marked A is the elastic limit and a point marked B a little farther to the right is called the stretch limit.

It is difficult to determine the true elastic limit without the aid or use of delicate measuring apparatus reliable to less than

* These are shown in a horizontal instead of a vertical position, such as they would have in the machine.

.0002 of an inch. The stretch limit is a little higher than the elastic limit and as it can be found much easier and quicker than the latter, it is often given as the elastic limit. If the scale beam is balanced with loads on the specimens and allowed to remain under load for a minute or two, it will be found that, up to a point in the immediate vicinity of the elastic limit, the scale beam will still be balanced at the end of the time. On passing a trifle beyond the elastic limit. it will be impossible to keep the scale beam floating unless the loading screws are drawn down continuously. The point where the specimen would not hold the load balanced is the stretch limit. A point somewhere near the elastic limit, between the elastic limit and the stretch limit, may be found by counting the number of teeth the hand wheel cog advances in putting on successive 1,000 lb. loads. If the specimen does not slip in the holders, the number of teeth will be about the same for each load till after the elastic limit is passed when the number increases rapidly.

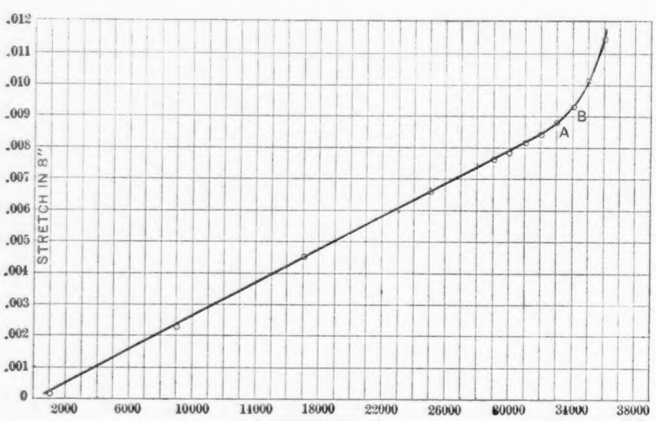


FIG. 3. STRETCH CURVE.

On many testing machines the stretch diagram is drawn by the machine. A measuring device arranged to multiply the stretch of the specimen many times records on a paper drum moved to correspond with the load shown on the scale beam. The diagram is then interpreted as explained. After passing the elastic limit, the measuring clamps are removed from the specimen and the maximum load which can be put on the piece is noted. The maximum load is reached in the case of iron and mild steel some time before the specimen fails. After passing the maximum load, the specimen pulls down rapidly, behaving much as molasses candy would, and finally fractures as shown by the cut Fig. 4.

The ultimate stretch is found by putting the broken pieces together and measuring the distance between the points where the measuring clamps gripped the specimen. This distance can-

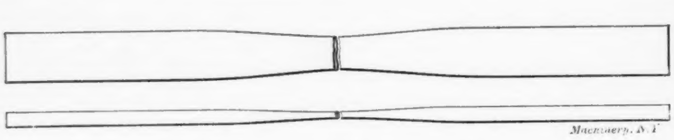


FIG. 4. BROKEN SPECIMEN.

not be measured closer than 1-100 of an inch. In this case the distance was 10.24", giving 2.24" or 28% of stretch in 8 inches. The dimensions of the fractured section are taken and the reduction in area figured. The fractured section as measured was .95×20" giving an area of .190 square inches. The reduction is .500—.190=.310÷.5 gives 62% as the reduction.

The modulus of elasticity in pounds per square inch is the load per square inch divided by the stretch per inch of the length produced by the load. Suppose the modulus of elasticity to be calculated between the loads of 500 and 12,500 as shown on the scale beam. The difference between the mean readings of the micrometer at these loads is .0064" as the stretch in 8" or .0008" per inch for an increase in load of 12,000 lbs. on the scale beam. As the original section of the boiler steel was 5" area, this corresponds to an increase of load of 24,000 lbs. per square inch 24,000÷.0008=30,000,000, the modulus of elasticity. The modulus of elasticity is calculated with loads under the elastic limit. A small initial load is commonly taken as the starting load. This ensures the gripping of the wedges, and all the levers of the machine are brought to a bearing..

When the testing machine shown by Fig. 1 is to be used for comparison work, the hole in the pulling head is filled by a hardened steel disc, so arranged that it can swivel a trifle to allow for any lack of parallelism in the two bearing surfaces of the specimen.

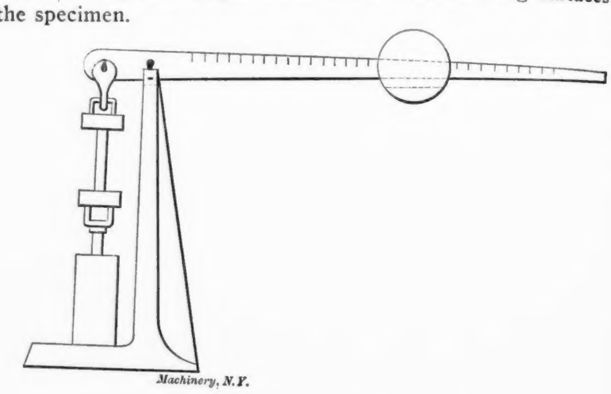


FIG. 5. SIMPLE LEVER MACHINE.

The piece to be tested is placed between the pulling head and the platform. There are many different forms of testing machines. Those which are accurate are arranged to weigh the push or pull transmitted through the specimen. In some inaccurate machines the load is applied by a hydraulic cylinder and figured from the pressure and the area of the piston. The piston or packing friction is variable and may amount to more than 25 per cent. of the calculated load; hence the amount of load on the specimen cannot be told.

A simple form of lever machine used to quite an extent in England is shown by the sketch, Fig. 5. There is a hydraulic cylinder for applying the load to one end of the specimen and a single lever with heavy poise weight, often 2,000 lbs., for weighing the load at the other end of the specimen.

In the laboratory of the Massachusetts Institute of Technology is a 300,000 pound Emery testing machine for both tension and compression tests. This machine has so many interesting features that the Editor has asked for a more extended description than was originally intended. As this can best be given in a separate article, the description will be deferred until the other subjects of the series have been completed.

Transverse Tests.

By means of transverse tests we determine the strength and stiffness of timber beams, trusses, iron girders and I beams, cement beams, etc. It is especially desirable that transverse tests should be made on full-sized specimens. Most of the large testing

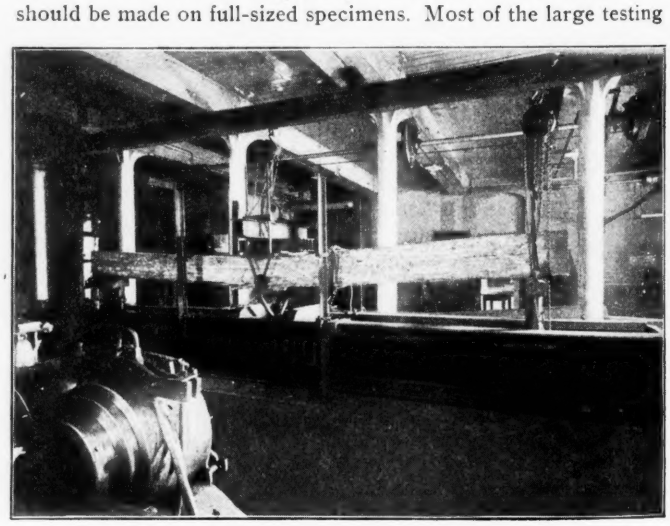


FIG. 6. FRONT VIEW OF LARGE TRANSVERSE TESTING MACHINE.

machines for this class of work are "home made." Figs. 6 and 7 illustrate a large transverse testing machine used in the engineering laboratory at the Massachusetts Institute of Technology. It is of 100,000 lbs. capacity, and will test a specimen up to 26 feet span.

The machine is quite simple. Two steel girders rest at the center on a framework raised 4" above the floor. These girders

support two movable carriages which hold the jack-screws used for applying the load. At the center of the machine there are three levers used in weighing the load. Two of these levers are beneath the girders of the machine, and do not show in the cut. The main lever gives a multiplication of 10 to 1. It is of steel, about 6 ft. long, and at the larger end it is 13" deep and 2¼" thick. A steel yoke put over the specimen fastens to the lever system. The load is applied by raising the jacks at the ends of the specimen, and it is weighed through the pull exerted on the levers by the yoke attached to the center of the specimen. The steel girders forming the bed must carry, without undue fiber stress, the maximum load which the machine can exert.

Figs. 6 and 7 show a white pine beam which had been in service at least 75 years. The stick is 15" deep and 15⅞" wide.

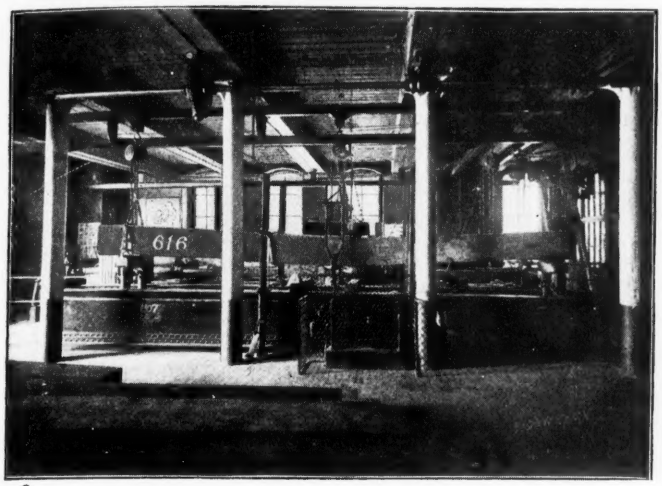


FIG. 7. BACK VIEW OF LARGE TRANSVERSE TESTING MACHINE.

The span was 20 ft. In the test made on this beam in the testing machine the load was applied at two points, one foot either side of the center. The manner of distributing the load is shown by the I beams at the center of the machine. The deflection of the beam was measured in the following way: On either side of the beam a fine steel wire was stretched over pins driven into the beam directly above the supports and at the center of the depth. A ten-pound weight on the end of each wire kept the wire in tension.

A micrometer was fastened to each side of the beam at the center of the length and depth of the specimen. The face of the micrometer screws was set parallel with the wires, the screws being perpendicular.

TRANSVERSE TEST.

No. 616. Date, October 21, 1899.

Specimen—White pine beam taken from an old market on State Street, Boston. Specimen at least 75 years old.

Loads.	Micrometer Readings.				Mean.	Differences.	Remarks.
	1	2	1	2			
1	2	3	4	5	6	7	
1,000	.0156	.0155	.0210	.0212	.0183	....	This specimen was hand-hewed. It was perfectly dry.
6,000	.2260	.2260	.2419	.2419	.2340	.2157	
11,000	.4452	.4452	.4702	.4704	.4578	2238	
16,000	.6575	.6575	.6920	.6918	.6747	.2169	The failure was by a tension break.
21,000	.8760	.8762	.9130	.9132	.8946	.2199	

Manner of loading—At two points 12" either side of center.

Span	20 feet.
Dimensions	15" deep, 15⅞" wide
Weight of yoke, &c	727 lbs.
Weight of beam	953 lbs.
Maximum load by scales	63,975 lbs.
Maximum load on beam (including yoke, but not including weight of beam)	64,702 lbs.
Deflection from 1,000 lbs to 21,000 lbs. load	.8763"
Modulus of rupture (including weight of beam)	5917 lbs.
Modulus of elasticity between 1,000 lbs. and 21,000 lbs. load	1,450,800
Maximum intensity of longitudinal shear (calculated by ordinary formula, weight of beam included)	206.8 lbs.

To take a set of readings, the screws were turned down till contact was made with the wires; then the readings were taken. In the log given above, which represent the test on piece No. 616 shown in the cuts, two sets of readings were taken on each micrometer. Columns 2 and 3 are readings on one side and columns 4 and 5 on the opposite side. Micrometer readings were discontinued above 21,000 lbs. load. With the high loads, the deflection will depend to a consderable extent on the length of time the load was left on the specimen before the readings were taken.

In the calculation of the results following the log no explanation of the formulas used will be given, as these may be found in every work on applied mechanics and in most of the engineers' handbooks.

If we neglect the weight of the beam itself, the bending moment, due to the load, will be uniform for a distance of 2 feet at the center, and gradually grow less till at the supports it is zero.

The bending moment due to the load on the beam is equal to

$$\frac{64{,}702}{2} \times 9 \times 12 \text{ inch pounds.}$$

The beam itself weighs 953 pounds. This weight is uniformly distributed and the bending moment due to this will be a maximum at the center of the beam equal to

$$\frac{953 \times 20 \times 12}{8}$$

The sum of the bending moments must have been equal to the apparent outside fiber stress f, times the moment of resistance of the section $\frac{I}{y}$ where I is the moment of inertia about the neutral axis and y is the distance from the center of gravity of the section to the outside edge.

$$\frac{64{,}702}{2} \times 9 \times 12 + \frac{953 \times 20 \times 12}{8} = \frac{f \times 15.875 \times \overline{15}^2}{6}$$

f called the modulus of rupture calculates as 5,917 lbs. The modulus of elasticity E is calculated by means of the formula for deflection. The formula for deflection for a certain increase in load is, for this manner of loading and for the spans taken

$$= \frac{283{,}834 \text{ load}}{E\,I}$$

By increasing the load from 1,000 to 21,000, the deflection was increased .8763".

$$.8763 = \frac{283{,}834 \times 20{,}000 \times 6}{E\ 15.875 \times 15 \times 15 \times 15}$$

$$E = 1{,}450{,}800$$

This expression for deflection may be derived from that given for a beam loaded at a point one side of the center.

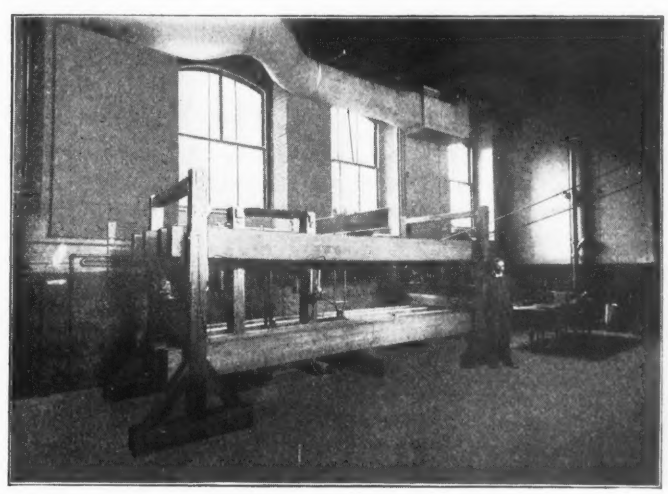


FIG. 8. MACHINE FOR TIME TEST OF BEAMS.

The deflection at any distance x when x is less than a is

$$v = \frac{W\,(l - a)}{6\,l\,E\,I}\,x^3 + \frac{W\,a}{6\,l\,E\,I}\,(3\,a\,l - 2\,l^2 - a^2)\,x$$

Put W equal to 10,000, l = 240, a = 132, x = 120, and the value v or the center deflection due to W will be found. Another load of 10,000, placed an equal distance the other side of the section, would produce an equal deflection, hence twice the above expression will give the value for the loading shown for the beam in Figs. 6 and 7.

The maximum intensity of longitudinal shear is calculated from the formula

$$\frac{3\ (\text{breaking load} + \text{weight of beam})}{4\ \text{breadth times depth}} = \frac{3 \times 65{,}655}{4 \times 15.875 \times 15} = 206\ 8\,\text{lbs.}$$

This is greatest at the support. When a beam bends, the upper half being in compression and the lower half in tension, there is a tendency for one part to slide by the other splitting through the center. This action takes place quite frequently in timber beams.

Time Tests of Timber.

If a timber is kept loaded for a long time, the deflection resulting is nearly double that which would take place when the load was first applied. It is very common to find floors in mills which show the effect of this increased deflection with time. When the deflection, after years of loading, must not exceed a certain amount, the size of the timber has to be made considerably larger than would be figured by using the ordinary safe fiber stress.

A number of experiments in this line have been made at the Massachusetts Institute of Technology in past years. The results of these tests are given in Lanza's Applied Mechanics.

Fig. 8 shows a recent machine built to test large timbers. There are eight 6" x12" yellow pine beams of 15 ft. span in the machine at present. These have each been loaded with 6,330 lbs. center load since March.

The deflections were measured at first every day, later every week.

The moisture in the air and the decrease in cross-section, due to seasoning, are also recorded.

* * *

One of the remarkable operations in glass manufacture is the making of tubing for thermometers, especially for those used by physicians. The diameter of the bore is so small that it is scarcely discernible to the naked eye when not filled with mercury, probably being not over one-thousandth of an inch in diameter. The diameter of the hole must approximate a uniform size, but such is the remarkable viscosity of glass and the skill of the operator that at the Corning Glass Works this tubing is drawn regularly to a length of over eighty-five feet.

The method of drawing is quite interesting and is done by one man and a helper who have become expert at the business. By improvements in the process of manufacture the Corning Co. are said to have practically a monopoly of tube making. One of the prominent features of their process is the use of a tower into which the tubes are drawn and allowed to hang vertically until cool when they are lowered and cut into sections of convenient length.

* * *

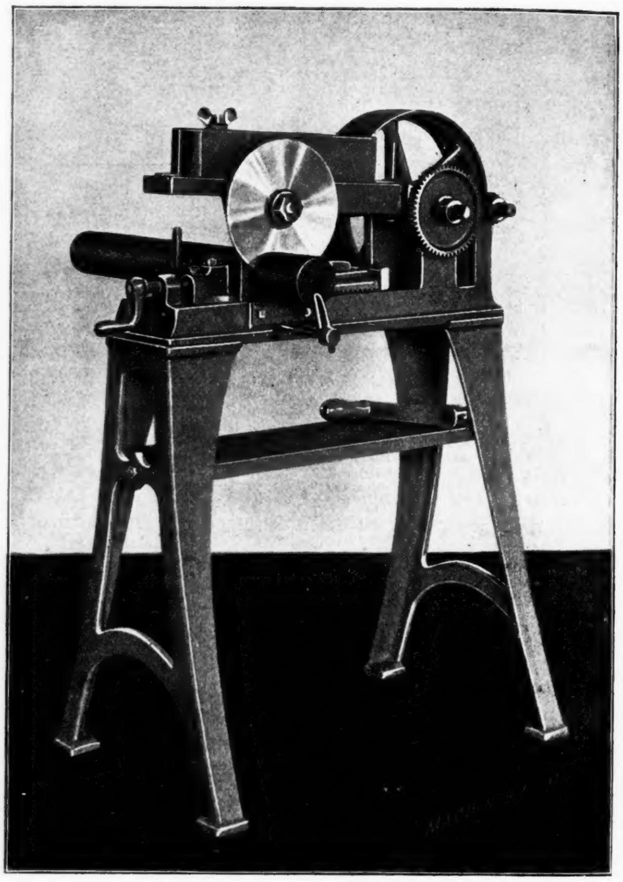
CIRCULAR SAW FOR MACHINE SHOPS.

It is but comparatively few years since the shop saw came into existence, but it is used extensively, partly, probably, because of its low first cost and partly because, in spite of its defects, it has proved to be a very useful machine. We illustrate in this number a new circular metal saw designed to do the work of the power hack saw, but in a better manner. The circular saw has been entirely successful for sawing heavy structural shapes and this adaptation of the same principle to ordinary shop work presents some very interesting features. As will be seen, the saw is supported by an overhanging arm which swivels at one end and can be raised clear of the work if desired. Power is transmitted from the pulley shaft, through the two spur gears shown, to a pair of bevel gears, one of which is on the shaft with the larger spur gear and the other on a short shaft running at right angles to the saw arbor and connecting with the latter through another pair of bevel gears. The supporting arm for the saw swings about the center of the shaft carrying the larger spur gear. Two speeds, for sawing either hard and soft metals, can be obtained by transposing the two spur gears and the saw can be operated either by belt or hand power. The crank will fit either of the driving shafts, thus allowing a slow, powerful motion, or a rapid motion, as desired.

The feed is by means of a weight placed on top of the swinging arm and the feed is graduated by sliding the weight out or in. Among the special features of the machine are an adjustable post to regulate the depth of cut, and removable vise jaws, which enable special work, that cannot be held in the vise, to be done. This also makes it possible to saw at any angle.

It is claimed by the makers that the machine will saw straight with no loss of stock from the saw running sidewise; that the circular saws do not break in actual use and that they can be sharpened in a few minutes by unskilled labor, a small emery wheel and grinder being furnished for the purpose; that the saw will wear down only about an inch a year in an ordinary jobbing shop where reasonable care is taken in grinding, and that a saw will stay sharp long enough for a day of hard sawing and then will simply need to be touched up at the points.

A sample has been sent us of the end of a tube cut with this saw. The tube is 1¾ inches in diameter and a piece 1-16 inch thick was cut off, which shows a smooth, even cut. The pressure necessary to make a saw cut depends very much upon the number of teeth in contact. In sawing a railroad rail, for instance, more pressure will be required in sawing through the ball than in sawing through the web. It is not possible to entirely overcome this, but in sawing different diameters of round stock something is gained by having saws with coarser or finer teeth, using coarse teeth on large diameters and fine teeth on small diameters and tubes.



NEW METAL SAW.

If the saw be perfecty round, all the teeth in contact must cut, or none; therefore for the gravity feed there is an advantage in not having the saw perfectly round, for when the teeth are somewhat irregular, only the high ones cut when operating on large stock, while they all cut in small diameters. The saw acts more like a file than like a cutting tool and hence the shape of the tooth is not so important as its sharpness, which can be easily maintained if taken at the right time. Thin tubing requires a fine toothed saw, so that the distance between the teeth should always be less than the thickness of the tubing, as otherwise the teeth will catch. The machine is for sale by the Marshall and Huschart Machinery Co., Chicago, and appears to us to be a machine of considerable novelty and interest.

* * *

A Springfield, Mass., paper is credited with the following item: "The molders are grinding their axes and sharpening their sledge hammers to go to battle with the Springfield Foundry Co., which is using four scab wheelbarrows that were bought of the ——— company."

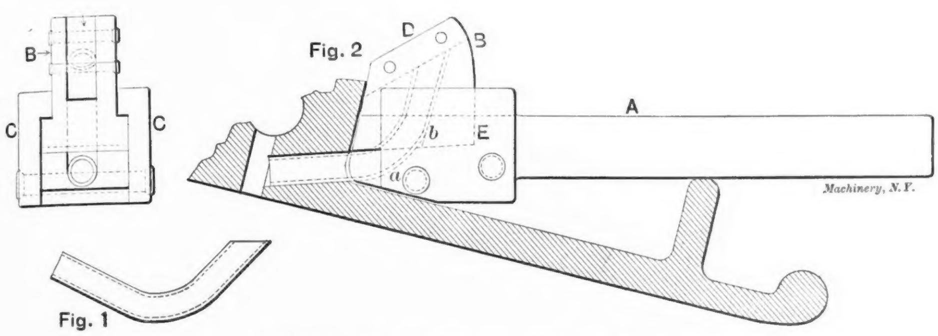
Lumbermen, blacksmiths and molders are all one in the eyes of this reporter. With a strike of this kind in progress somebody is likely to get hit.

LETTERS UPON PRACTICAL SUBJECTS.

A TOOL FOR SETTING AN OIL TUBE.

Editor MACHINERY.

This tool is one of the special tools that it was found necessary to build in manufacturing a new machine; a simple tool and one that fulfils all requirements. Its use is necessary when driving a curved oil tube, as shown by Fig. 1, into a piece of the machine where there is but little room, and in such a way that the curved part only will remain out. It was a little puzzling at first to know how to hold the tube while driving it in without changing its form or bruising the end. A tool was made, however, for the purpose and found to be satisfactory. It is shown in Fig. 2. A is a handle, at the end of which is a sliding block B. The sliding block is held in place by straps C, riveted to the handle. You will notice a form cut in the handle at (a) and also in the sliding block at (b), which is the same form as the oil tube. Riveted in the sliding block is a piece D, which makes the stop for the end of the tube, and the shoulder E forms the stop for the sliding block.



HOLDER FOR DRIVING OIL TUBES IN PLACE.

The operation is as follows: Place the bent end of the tube into the sliding block, then slide the block and tube on the handle until they come against the shoulder. This gives a solid holding so that the tube may be driven into place without harm.

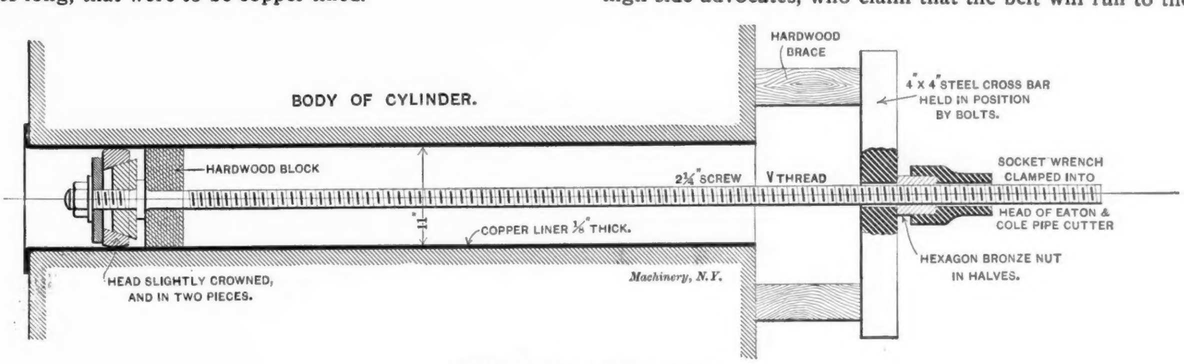
To remove the tool after the tube is driven in, draw the handle up. This allows the block to slide out easily, as the ways are slightly tapered. Then remove the block and the tube is in position. EDWIN C. THURSTON.

* * *

METHOD OF EXPANDING COPPER LINERS IN CYLINDERS.

Editor MACHINERY:

In the manufacture of some large presses some time ago, there were some cylinders eleven inches in diameter by about ten feet six inches long, that were to be copper lined.



EXPANDING A COPPER LINER.

The following is a description of how this was accomplished: After the cylinders had been bored out and faced off, they were placed in a horizontal position and well supported. The copper liner, which was seamless drawn, was placed with one end entering the cylinder.

Across the other end of the liner, which was flanged, was placed a stout block of wood, to which was attached a block and fall. This was passed through both liner and cylinder, and secured at the front end of the cylinder. The liner was then pulled into place, being just large enough to go in under slight pressure, and of sufficient size to keep it from buckling due to the pressure applied, notwithstanding its length.

After the liner was in the cylinder it had to be expanded to make it fit the cylinder bore snugly and take out any indentations which may have been made.

The following was the method used: A cast-iron expanding head was made, consisting of an inner and outer piece fitted to each other on a taper, as per sketch.

The outside diameter of the head was turned slightly crowning so that the edge would not cut the copper, and also to allow for any non-alignment of screw.

This head was fitted to the end of a long bolt extending through the cylinder to the front end. The bolt was threaded almost its entire length, for a bronze nut which was made in two pieces so as to be easily removed, and which was held in a socket wrench at the front of the cylinder. Behind this nut was placed a four-inch steel cross bar, through which the screw passed, and which was braced against the face of the cylinder by two pieces, as shown, so that all strains were self-contained in screw-nut and cylinder. The socket wrench, before mentioned, was clamped into the head of an Eaton & Co. pipe cutter, and after the screw was centered, the machine was started, drawing the expanding head through the cylinder.

This operation was repeated as many times as was necessary, the head being expanded a little each time, by means of the nut and washer at the back of the head acting on the outer part of head, which outer part was in two pieces.

The head was well doped in grease so that it would move freely and not cut the copper.

A hardwood block of proper diameter was placed in front of the head to serve as a steadiment.

After the liner had been sufficiently expanded, the inside was well polished with emery cloth and oil, to ensure as nearly as possible a frictionless surface.

These cylinders were worked under a pressure of about thirty-eight hundred pounds per square inch. A. DUNN.

* * *

LEVELING WORK.

Editor MACHINERY:

This week the old topic of alignment of shafts came up with its high side advocates, who claim that the belt will run to the highest side of a pulley when the shafts are closer at one end than the other. I have met many good machinists who held this view and it was hard work to convince them to the contrary. Every machinist has heard so many times that a belt will climb to the highest side, that he takes it for granted to be true. The fact is, that it runs to the lowest side of the pulley when the shafts are not in line, that is, when they are not parallel with one another; or another way to state the case is, the belt will run to that side of a pulley where the shafts are nearest each other.

Another case came up where the shafts were out of alignment

horizontally, that is, one shaft was level, the other was not by ¾" in four feet. The man who was sent to get the machine in line and started, reported as above, and was told it made no difference about that. While he said nothing, you could tell by the smile on his face, he did not believe it, but he was convinced when he started the machine. To have leveled up this machine would have cost considerably more, on account of attachments already made, and after leveling, it could not have run any better than it does now. However, the manager of the plant for whom the work was done was informed of the conditions as found and he put the question if it made any difference in the running of the belt on the pulley, and was told that it did not, when he replied he thought so.

This leveling business brings to mind a case where no level was to be had and an ordinary washtub was used instead by filling it nearly to the top with water, then blocking a straight edge up parallel with the water and working from this. It all depends on the circumstances as to what to use; for instance, in a field you might dig a shallow ditch and fill it with water, set a straight edge with the surface and go ahead; or you may take a piece of pipe and bend it at both ends and fill with water. These methods all accomplish the same end. But there are places where I seriously object to using a level, and that is for setting work in the shaper, lathe, ,drill press, planer or any machine where you have a platen or bed to measure from. I have seen work leveled by men who know better if only they would think. Suppose the machine is not level? (a good many are not that have come under my observation), and it is generally supposed to be so, for when this question is asked the answer is: If it is not level then I am not responsible. You can, of course, make the same allowance in your work that there is in the machine, but to my mind this is very unsatisfactory as compared with measuring from a bed or platen. A. MERTES.

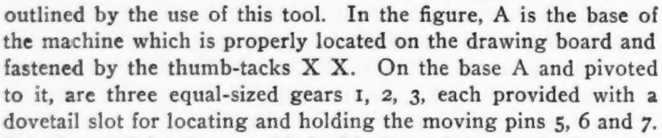
Emsworth, Pa.

* * *

A DRAWING MACHINE.

Editor MACHINERY.

The machine tool here illustrated is designed to outline correctly an ellipse of any desired proportions between a straight line and a circle. Oval or egg-shaped figures having one end larger in diameter than the other and other curved figures can also be outlined by the use of this tool. In the figure, A is the base of the machine which is properly located on the drawing board and fastened by the thumb-tacks X X. On the base A and pivoted to it, are three equal-sized gears 1, 2, 3, each provided with a dovetail slot for locating and holding the moving pins 5, 6 and 7. B is the outlining bar provided with three slots, two in the same line and one at right angles to them. These slots fit the pins 5, 6 and 7, and the motion of the bar 3 is guided by the position of these pins on the gear. If the pins were set in the center, then



APPLIANCE FOR DRAWING ELLIPSES.

bar B would not move at all. If pins 5 and 7 are set at the center and 6 at 1" radius, we have a straight line 2" long. If 6 is at the center and 5 and 7 are at 1" radius, then we have another straight line at right angles to the other. If we set 5 and 7 at ½" radius and 6 at 1" radius, we have an ellipse 2" long by 1" wide correctly outlined. If 5 and 7 are at 1" radius and 6 is at ½" then we have produced a duplicate of the preceding ellipse at right angles to it. If all the pins are set at 1" radius, then we get a circle 2" in diameter. We cannot enter into the possibilities of the great variety of forms of figures, reversed curves, etc., which, with the aid of this tool, can be traced, according to the manner in which the pins are set and the relations of the gears which may be changed so as to mesh differently. In constructing this machine tool, it should be made large enough to describe at least a 6" circle. One feature of the work produced on paper by this machine tool is the absence of all center points.

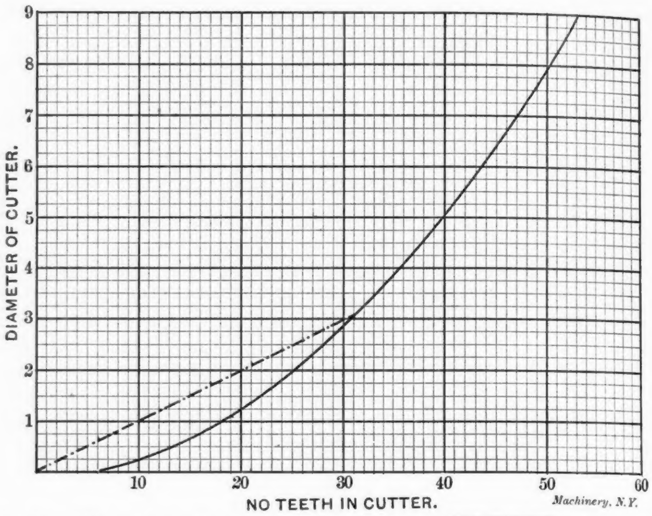
Boston, Mass. F. W. CLOUGH.

* * *

PITCH OF MILLING CUTTER TEETH.

Editor MACHINERY:

I send you herewith a diagram which shows at a glance the number of teeth that milling cutters of different diameter should have to conform to the formulas on page 958 of Kent's pocket



book. These formulas are: Pitch $= .177\sqrt{\text{diameter}}$, and number of teeth $= \dfrac{3.1416\,d}{P}$. Milling cutters proportioned according to these formulas give good results in practice. In most cases for cutters under 3 inches in diameter use the dotted line, which gives 10 teeth per inch of diameter. RAY CARPENTER.

* * *

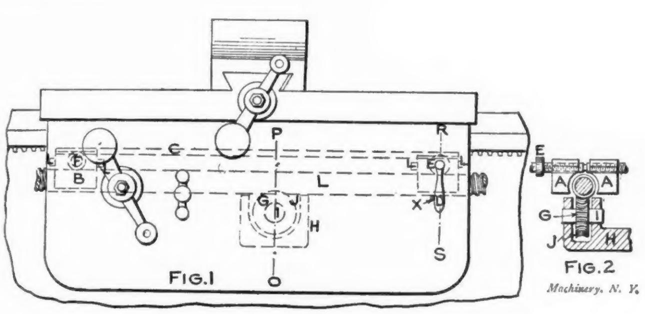
A SUGGESTION IN LATHE DESIGN.

Editor MACHINERY:

My attention has been called to the suggestion by Mr. Olin Snow in the November issue of MACHINERY, that it would be an improvement to have engine lathes built with reversible lead screws. By having the screw reversible, the trouble incident to the local wear on this vital part of the lathe would, he believes, be overcome. He says that the greater part of the wear on the screw is limited to a portion next to the head-stock, and by making the screw reversible, the same effect practically would be realized as though the screw were replaced by a new one. The writer's experience has taught him that the condition mentioned by Mr. Snow is quite common on old engine lathes, and that it is a serious defect when long screws are to be cut on such machines. It probably would not be far from the truth to say that nearly nine-tenths of the work threaded on engine lathes is done within a range of two feet of the head-stock, and an examination of nearly all old lead screws will show a distinct jump in the lead near the limit stated. To overcome the defect, it is quite common, when repairing old lathes, to reverse the lead screw and thus obtain a practically unworn part for the split nut to work in. To reverse an ordinary screw is, however, quite a job and one quite unlikely to be undertaken unless urgently demanded. Having seen lead screws reversed and having noted the trouble incident to the change, I have thought of the reversible feature and have wondered why some of our enterprising manufacturers have not incorporated the feature in "one of their latest and best lathes with double back-action and patent medicine attachment." But after thinking considerably on the subject, I am convinced that, while the reversible lead screw may be a good arrangement if rightly used, it would, however, fail to be a benefit in the great majority of cases. In the first place the reversing of the screw would take quite a little time. A machinist would never think of reversing the screw unless he was given a job that positively demanded it, and having made the change, he would very likely not change it back again unless specific instructions were given him by the foreman to do so. If the screw were left in the reversed position, the screw would eventually become worn in the same way as before, and if a long

screw were to be cut, the results would be even worse than in screws that had never been reversed, as there would be two inaccurate places in the generated screw instead of only one, as ordinarily occurs. Even under ideal conditions in which the screw is turned and worn as nearly equal as possible at both ends, a perceptible jump will surely occur at the junction of the worn part with that which is practically unworn.

Having advanced my objections to the reversible scheme, I will now offer my improvement (?) for the consideration of MACHINERY readers. Since the wear on the lead screw comes within a limited distance of the head-stock, and we accept that it is practically limited to two feet or about the width of the apron of a twenty-inch lathe, it is obvious that if a split nut be located on the left side of the apron and used for all short work, the wear on the lead screw will be limited to that portion which is covered by the carriage. Then by having a second split nut on the right side of the apron in the ordinary position and using it only for accurate and long screws, it would be engaged with a portion of the lead screw that is practically unworn throughout its full travel instead of for a portion as with the reversible screw. The split nut on the left side of the apron would, of course, involve cutting the screw somewhat longer than is necessary now, but that is a minor matter. The two split nuts and other necessary features would increase the cost somewhat over the present construction, but it seems to me that the results attainable would easily offset this disadvantage.



PROPOSED CHANGE IN LATHE APRON.

The method proposed for working the two nuts is shown in Figs. 1 and 2 in a general way, the minor details being omitted for clearness and simplicity. The split nuts open horizontally instead of vertically, as in the usual construction, and are operated by right and left screws. The screws should have a pitch of, at least, ¾", which would give an ample opening with one-half turn of the handle D. The right and left screw K, to which the handle D is attached, also carries the pinion gear E, which transmits motion through the rack C to the right and left screw F. The latter screw operates the left split nut B. The action of the two nuts is opposed, that is when the right nut is closed, the left nut is opened still farther from its normal open position that both occupy when each is disengaged from the lead screw. Vice versa, the right split nut is opened when the left one is closed, this being effected by having the right and left screws reversed in the jaws of the nuts so that when they turn in the same direction, an opposite effect is obtained. Now by having a stop pin X located so that the handle D can only be thrown to engage the left nut when threading ordinary work, we have the condition of affairs which has been outlined as being desirable. The screw is only being worn for a short distance which lies between the two nuts, and when an accurate or long thread is desired, it is an easy matter to remove the stop pin and turn the handle D in the opposite direction, thereby closing the right split nut on a practically unworn portion of the screw which continues for the full travel of the carriage and not for a limited portion of it only. It appears to the writer that this scheme is perfectly feasible and is quite desirable, but to his knowledge it has not been applied in general practice. If any readers know of a similar device, a description would, I believe, be interesting to the readers of this journal.

Before I close this description of what Mr. Snow will probably designate as a "freak" design, I wish to speak of another feature of lead screws which is generally neglected, and that is the need of a support beneath them near the middle. Some makers apply an elaborate "kick up" arrangement that lowers when the carriage approaches and raises after it has passed. While this device accomplishes the purpose for which it is designed, it is scarcely an elegant or creditable arrangement for a machine tool. On shorter lathes, hooks are employed, which are supported from the shears to carry the weight of the screw, but it is obvious that the machinist cutting a long screw, has something more to think about than sliding these hooks along so that the screw does not sag. The result is that the screw is not supported at just the time it should be, since the deflection of a moderately long screw which is unsupported must certainly have an appreciable effect on the accuracy of the thread being generated. The weight of the screw being carried by the nut, the wear on this part and on the screw is unnecessarily increased. To obviate these troubles, I will offer, with the other "freak" scheme, the idea of supporting the lead screw by a number of wheels, like G, which may have shallow teeth cut, thus making them worm wheels that will revolve slowly by the motion of the lead screw. The construction of the split nuts enables this form of support to be used without difficulty. The supporting arrangement keeps the screw in perfect alignment, and also feeds a constant supply of lubricant to the screw from the cavity J, which is to be filled with a thin oil. The lubrication of lead screws is something that is often neglected, and one of these supports would be a good thing on the shortest lathes built, as it would fulfill the lubricating feature admirably even if it were not needed to support the screw.

Fig. 2 shows a section of the supporting device through the line P O, and a section of the split nut A through line R S, the two sections being combined for convenience.

I notice that Mr. T. B. C., in a letter published in the December issue, pitches into my proposed shaper-slide adjustment and lets daylight into it without any compunction whatever. He has my thanks for availing himself of the privilege which the editor of MACHINERY seems to extend to all—that is, the right of expressing individual opinions. But, while in theory I can agree with Mr. T. B. C. that: "Any design that tends to place the adjustments of machine parts out of the instant reach of the operator is radically wrong, and also that an operator who is not capable of looking after the proper adjustment of the machinery in his charge is incompetent, etc.," practice has taught many a tool-builder that the less chance allowed for adjustment, within reasonable limits, the better. The writer not long ago saw a new gear-cutter in process of construction which was specially arranged so that the operator could make no mistake in the setting and could not by mistake tighten the slide so as to interfere with its proper action. A movable head which was provided with adjustable gibs was, however, arranged so that a large screw-driver would be necessary to effect any change in the adjustment. In short, the whole machine was so constructed that the operator could not "tinker" with it, as bitter experience had taught the builder the danger of the practice. Mr. T. B. C. must remember that all men who run machines are not machinists, and that the proportion that are is steadily decreasing every year, and for this reason the machine that offers the least temptation to the "tinkerer" is likely to give the best satisfaction in the end.

F. EMERSON.

Newark, N. J.

* * *

CRANES HIGH AND CRANES LOW.

Editor MACHINERY.

The title above is not intended to hint at an analysis of the ceiling-room required for installing cranes in general, but merely seeks to set forth certain variations in the price of these useful machines which seem almost abnormal.

Not many years ago the writer had occasion to buy two 4-ton traveling cranes, with hand-chains for performing the respective functions of hoisting, traversing the trolley and traversing the bridge, the span of the latter being about 16 feet—with a load rise of 12 feet. He drew up a somewhat meager specification which, however, covered the important points of ample strength, reasonable durability, convenience in handling, ease of working, due to roller bearings in both trolley and bridge wheels and, of course, the capacity to handle 4-ton loads.

These specifications were sent to nine of the best-known

makers of such articles, with results as regards prices shown in the table below, the bidders being marked respectively A, B, C, D, etc. The last column quotes remarks appended at the time of receiving and tabulating the bids, but will hardly be supposed to furnish information in the language of the bidder. There were a number of other columns in the original table, giving a variety of data which it is hardly worth while to mention herein.

Bidder.	Net Price.	Days for Delivery.	Remarks.
A	$1220	42	Good—but they want the earth and the fullness thereof—too much weight —and wait.
B	$654	30	No roller bearings—too dear—has worm-gears to waste power.
C	$556	21	Too dear—too heavy—too worm-geary.
D	$554	21	Good — spur-gears —2 speeds—quick lowering—chilled wheels.
E	$528	15	Good — spur-gears —2 speeds—somewhat rough finish.
F	$520	30	Good—best and handsomest design—spur cut-gears—chilled wheels, etc.
G	$491	21	Too dear—too light—worm-gears.
H	$436	21	Fairly good — spur-gears—2 speeds—somewhat rough.
I	$376	21	Good, but a little rough —spur-gears—2 speeds—low price.

The somewhat startling results in the matter of prices are shown as ranging from $376 to $1220 for the aggregate of the two cranes complete, delivered at destination without allowing for the permanent tracks on which the bridge-wheels were to run. In considering the tremendous differences in these figures, which seem to vary more than a set of bids for similar machinery usually does it is only fair to say that some of the cranes bid upon were a good deal heavier than others, and that some were finished in a much more elaborate manner, the higher priced ones being built more in the style of machine-tools, while lower prices, in some cases, represented considerable blacksmith work. The weights ran from 1800 lbs. to 5700 lbs., but the price of the latter was less than half the price of one of the lighter ones. The 1800-lb. machine was 40% dearer than one of the heavier ones. The price per lb. ran from about 7 cents to 17 cents. The latter price, however, did not represent a very nicely built crane.

The matter of extra weight should not in the case of a crane be always regarded as a positive advantage, as it would be in a machine-tool. On the contrary, lightness, consistent with ample guaranteed strength and durability, would in a traveling machine of this kind be an advantage, by reason of the less power required for its operation—just as it would be in a bicycle, a trotting sulky or a railroad car. The features of fine finish and carefully-fitted joints would, of course, be desirable points in the make-up of a crane, provided they did not cost too much; but few users would be willing to pay 300% or 400% advance for these attributes alone. The matter of beauty of appearance would, of course, be worth something, but the writer could not find that any of the machines, with perhaps one or two exceptions, had any particular claims to æsthetic excellence.

Just why such a varied condition of crane prices exists, or did exist at that time, it is difficult to find out. It would seem as if some of the people wanted to make a great deal of profit or else intended to embody abnormally elaborate ideas in design and construction. The low bidders, on the other hand, must have been wiling to make their profit extremely small, approaching perhaps a minus quantity, and must have had a faculty for throwing things together rather roughly, but so that they would yet answer an excellent purpose. This has for several years past been manifested by certain two cranes which were purchased at the lowest price given in the table—and which have been at hard daily work.

This does not seem to be a case where cheapness of manufacture was obtained by making work in large batches on the duplicate system, or by the use of jigs and other special tools, or both, as in the traveling-crane business nearly every individual machine seems to be built to order to suit the special conditions under which it is to run.

Whether a perusal of this article may set the crane makers to studying as to whether they had not better start a "crane trust" for the unification of prices, is an unknown conundrum. Let us all devoutly hope that if they do they will not seek to market their products at prices anything like those given at the top of the table.

OBERLIN SMITH.

* * *

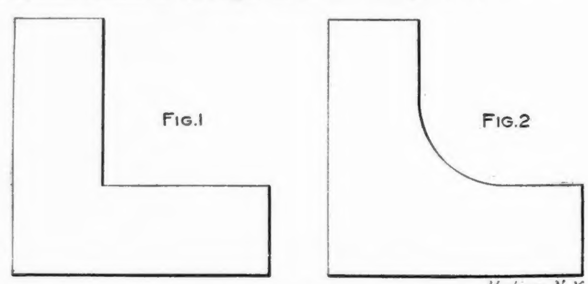
SMALL THINGS IN MACHINE DESIGN.

Editor MACHINERY:

In designing any piece of machinery some attention should be given to those small details which add to its durability and strength, and also to the safety and convenience of the men in charge. The following notes regarding some of these details may be of some value to young draftsmen.

When cleaning around an engine, if you get your hand ornamented with a few scratches and gashes from some nice (?) sharp corner, you will undoubtedly praise the chap that designed the engine in words that, in print, are best represented by dashes.

Now it is usually just as easy and cheap to have round edges as sharp edges and bayonet-like corners, and it is the same with hexagon nuts, have the chamfered side up and if there is any fear of scratching finished surfaces the angles of the nut can be slightly eased off on the faced side as is done with case hardened nuts. Square headed nuts are very frequently placed with the chamfered side next to the work so as to put less strain on the bolt, but they are used mainly for rough work where they are either out of sight or in a place that does not need frequent cleaning. Fillets should be used wherever an angle is formed, as it not only makes the part stronger than a sharp corner, but also makes cleaning easier, as it is almost impossible to take a bunch of waste and wipe out the dirt which gets in a sharp angle. A simple experiment will readily show that a round corner is the stronger. Take two pieces of paper and cut the one with a sharp corner and the other with a curve as shown in Figs. 1 and 2; now take hold of the round cornered piece at each end and pull until it tears apart, then tear the sharp cornered piece apart. This will be done with less effort than the former, proving that the round corner is stronger than the sharp corner.



FILLETS VS. SQUARE CORNERS.

When one piece of a machine moves to and fro on another piece it will in time cause wear and a shoulder will be formed; therefore, have the piece, on which the other slides, notched or grooved transversely, so that the sliding piece will pass over it slightly. This will prevent the formation of a shoulder, also a smash up when wear is taken up. A well-known example is the piston and cylinder of a steam engine, in which all danger of forming a shoulder is avoided by having a counter-bore at each end of the cylinder. Another example is the crosshead and guide. In these well known examples the provision for wear is seldom, if ever, overlooked, but in conical pieces it sometimes is. Frequently conical friction clutches need to be turned down to prevent slipping, but if the ends were notched no shoulder would have been formed, and consequently they would always work satisfactorily.

Pieces that are subject to wear should have enough metal added so that, when they need to be trued, it can be done without making the part so weak as to be liable to fracture. A piece of a machine may be sufficiently strong for the work it has to do, yet a slight blow or fall may cause it to break; therefore, all parts should be made strong enough so that they can be handled without fear of breaking. Mr. Meyer, in his excellent book, "Easy Lessons in Mechanical and Machine Design," gives an interesting example of a steam engine cylinder, 4 inches diameter by 6

inches stroke, the walls of which, if made strong enough to resist a steam pressure of 121 pounds per square inch, would need be only 3-32" thick.

Every machine is liable to have some part broken and the most expensive parts should be protected against injury by having some of the cheaper parts made weaker so that in the event of any accident they will break first and in most cases prevent further damage. For this reason it is a good plan to make the flange on a cylinder cover thinner than the flange on the cylinder, as a cylinder cover is a good deal cheaper to make than a new cylinder.

On machines that are so high as to need steps to facilitate getting at parts to be oiled, there should be hand rails so that there will be no danger of the attendants falling off. Likewise all platforms, no matter how wide, should have a railing, as one is liable to slip on the iron gratings of which the platforms are usually made.

Obviously, a pipe used for steam should never be used for a hand rail, but some years ago some economical crank conceived the idea of using the hand rail on the locomotive for conducting steam to the blower with the result that a number of firemen received burns and some had falls from the running-board before the practise was abolished.

Never use any contrivance which is liable to injure the persons working around it. To put a man's life in jeopardy for the sake of saving a few dollars, is, to say the least, inhuman. When a ladder is placed alongside a wall it should in no case be less than 2½ inches from the wall and when possible about 9 inches, as then there will be no danger of any one falling off for lack of room to get a good foothold. The ladder should extend about 2 feet above the top of the wall, chimney cap or whatever it may be, so as to have something to hold on when getting on or off the top, or, as in the case of freight cars, a handhold may be placed on top; about 12 inches from the edge is a convenient distance. In some places the ladders are placed close to the wall while there is plenty of room to have them further out. A ladder should always be inclined if room permits. There is one ladder that I remember very well, which was attached so near to the wall that it was necessary to place my feet lengthwise on the rungs, and, one day, when I had on a pair of new shoes, my foot slipped—and the force of gravity did the rest.

Have every part of a machine so that it can be easily examined and taken apart for repairs and without the use of special tools, if possible.

Proper facilities for oiling all moving parts should be allowed and where possible all such moving parts should be enclosed to prevent accidents. The coverings should be made so as to be easily removed when necessary and have suitable openings with hinged covers so that journals, etc., may be readily inspected.

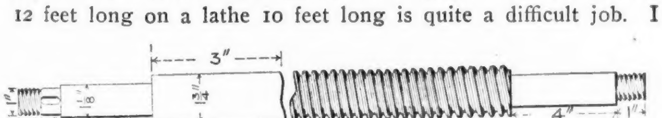
New York. CHARLES G. PEKER.

* * *

CUTTING A LEAD SCREW.

Editor MACHINERY:

As it is long since I have seen an article on lead screws in MACHINERY I take the liberty to revive the subject. A great many upon reading this article will say that it is not much of a job to cut screws. I admit that it is not, but to cut a screw 12 feet long on a lathe 10 feet long is quite a difficult job. I



THE SCREW THAT WAS TO BE CUT.

was employed one winter in a Wisconsin shop where, besides being engaged in building a small line of machinery, many other jobs were done. A short time after I commenced work in the shop, there came a dull spell and the proprietor decided to set his men at work on six 16-inch engine lathes he had begun to build some years previous, but which had never been finished. When it came to cutting the lead screws, the old hands were naturally given the preference, but they all said they could not do the job, as the largest lathe was not big enough. Then the proprietor, a man of few words, came to me and said: "Can you cut those screws?" I answered: "Yes." "I have no lathe in the shop" said he, "long enough to take the screws in, and for this reason the rest of the men refuse to cut them." I told him I thought they could be cut in spite of this difficulty, and he answered, "Go ahead." Now the longest lathe in the shop was 10 feet in length, of ancient design, and had been used very hard. Nevertheless I prepared for business. The screw being made of stock already turned the right size, I had only to cut the threads and "neck in" the bearings. The screws were in bars of various lengths, but some inches too long, and they were cut, as are all lead screws, the entire length with the exception of the portion at the head of the lathe. This was left uncut for the proper distance, while at the other end it was "necked in" for the bearing and threaded for a nut. The end at the head was also "necked in" for the bearing, turned for the driving gear and threaded for a nut. My first operation was to take out the spindle in the footstock, after which I bored a hole in a bronze bushing the size of the screw to be cut. Then I turned the bushing to fit the footstock in the place of the spindle, and as a follow rest was to be used, I made a bushing of the same size for that. I then drilled and tapped for a screw through the footstock and also for one through the bushing for the follow rest. Having a chuck placed on the spindle of the lathe, I put the end of the screw in same, letting it enter the width of the jaws which were one inch. I then adjusted the chuck till the screw ran perfectly true and secured the bushing to the follow rest on a line with the center of the work. Then I started cutting the screws, running the chip the whole length instead of cutting part way and using a steady rest. The screw, however, began to chatter so that nothing could be done with it. So I began an investigation to find the cause of the trouble, and loosened the bolts that held the bushing on the follow rest; but I could only get it off by unscrewing it with a pair of pipe tongs, and when I came to the uncut part I had to wring it around and wear it off. When it came off, I found that the sharp edge on the screw being cut had worn a thread in the bushing one-sixteenth inch deep. A machine steel bushing, case-hardened, lasted longer than the bronze one, but the screw cut just the same after it had worn through the case-hardening. Then the idea came to me to make one of cast iron. The bronze and steel bushings were worn out in cutting two screws and part of a third, the cast iron one cut the remainder of the six, and when these were cut I removed the bushing and found it in good condition. The next operation was to "neck" the screws for the bearing and the thread for the nut, which was accomplished by placing each end in the chuck, allowing enough to cut off the part in the chuck. Then the screw was turned and the other end was cut off. The screws when completed were accepted by the proprietor as being all right and were called by him a very neat job. A. F. NOTROH.

Providence, R. I.

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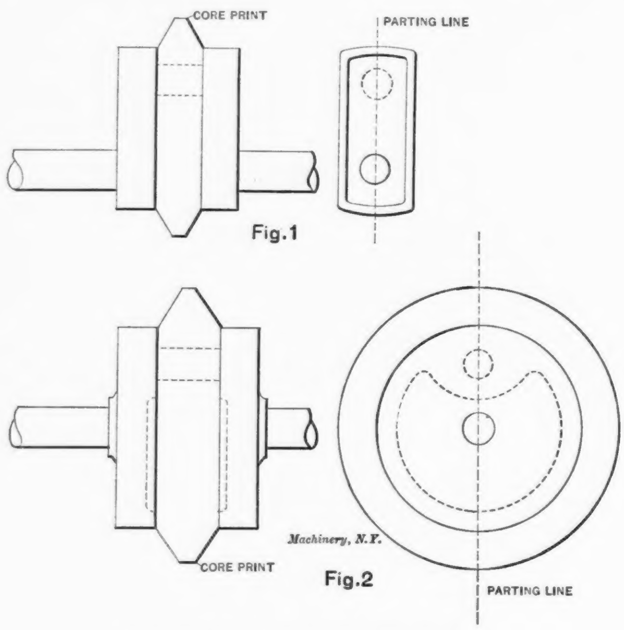
PATTERNS FOR CAST IRON CRANKS.

Editor MACHINERY.

Having had occasion, at different times, to use return, or bell cranks for different purposes, I tried forgings, cast iron and steel castings. Of course cranks for extreme duty should be forged of steel. Cranks of steel castings are amply good for a great many uses but are too expensive, forged cranks being cheaper and more reliable. Cast iron cranks, when properly made, and of the right proportions, will give excellent satisfaction for a great variety of uses. I have successfully used them in places where it was supposed that nothing but forged cranks would answer.

We are all well acquainted with cast iron engine shafts in engines made twenty-five or thirty years ago. In my recollection I can recall no case of a cast iron engine shaft breaking, but I do know of a number of breakages of solid forged cranks. I believe I am safe in asserting that I have seen at least fifty broken forged cranks and some of them quite large. Recently, I saw a five-inch electric light engine shaft broken and about the same time, one near the same dimensions, in an ice machine. The cranks used in oil-well engines break very frequently. Now I don't want to be understood as recommending cast cranks for all purposes, but I do know that they are entirely satisfactory for a number of uses and, by somewhat increasing their size, they will successfully replace forged cranks for many uses, and at much less cost.

In making patterns for cranks I formerly used a halved pattern, like the crank I wished to make, with the necessary allowance for shrinkage and finish. Patterns of this description are objectionable, however, because of first cost in pattern shop. Give a moulder a nice, new pattern like this and by the time he has driven a draw spike into it right by the side of a rapping-plate, pounded it this way and that way with a clamp, then, to make matters worse, has sponged enough water on it to drown a duck, or again, if the pattern should go to a steel foundry and survive the first spasm, the remains will rock a lullaby in a calm. To overcome some of these defects I have been making patterns about as shown in the sketch and have met with partial success. Of course you cannot make a pattern that the moulder will not destroy sooner or later, for he will just stay at it, without rest or peace, until his efforts have been crowned with success.



ARRANGEMENT OF CORES FOR CRANKS.

Fig. 1 shows a common crank, using a core to make the throat. Fig. 2 is on the same principle, being used to make double disc cranks. This method permits the pattern to be made in a more durable form, and in Fig. 2 to be cored out for a facing strip as shown by the dotted lines. In both cases there is need for only a half core box. HUGH HILL.

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POINTS IN WHEEL TEETH DESIGN.

Editor MACHINERY.

In reference to Mr. Webber's remarks on wheel teeth, November, 1899, I note that he points to the method of calculation of strengths on the basis of the whole of the pressure coming upon one corner of a tooth. Undoubtedly the whole pressure does come upon one corner of one tooth in the case of large cast gears and in fact in all gears if the bearings of the shaft become even very slightly out of line. The adherence to old methods is very strongly marked in the design of gear teeth. In a spur wheel

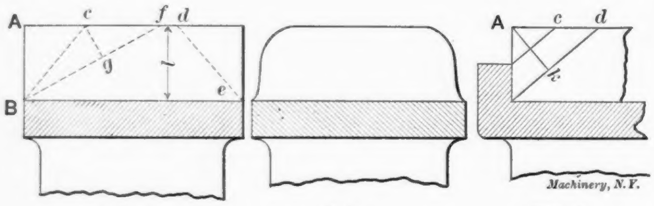


FIG 1. FIG. 2. FIG. 3.

the teeth stand up straight-edged from the wheel rim as though specially so formed in order to present the salient corner for the purpose of having the same broken off in due accordance with the formula for strength above referred to.

It would be more fitting to call it a formula for weakness. In Fig. 1 the line B C, along which the tooth would break if struck hard enough at A, would be inclined at an angle of 45 degrees if the tooth were parallel-sided; and B C would be the line of least strength of a homogeneous material. At least, so it seems to me. I have proposed to cut this corner B A C off the tooth from the beginning and to shape the tooth thus: B C D E. The tooth corner is now at C and if this point receives a severe blow, the tooth would break along the line Bf, the angle C Bf being equal to Cf B and C B being equal to Cf just as A C was equal to A B. By this design I have increased the strength of tooth in the ratio Bf to B C. It is now clear that assuming a corner blow at A and a fracture along Bf, no tooth can be stronger than the strength along Bf. The tooth, therefore, must be wide enough so that point f will fall to the left of corner d, and it need be no wider than this. The width to meet these requirements may be obtained by multiplying Bf by a certain factor.

To find the factor, we proceed as follows: From C drop a perpendicular on Bf; call this Cg; call the length of the tooth l; then the factor required is $l \div Cg$. Roughly, the width of Fig. 1 is double of Cg. Hence the maximum breadth of tooth Be will be twice Bf. This assumes, as above, rectangular teeth, and the conclusion requires modification because the tooth really thickens out to the root, and in proportion as the breaking strength is increased thereby, so may the breadth be diminished. Probably some such form as that in Fig. 2 would practically comply with the conditions of avoiding corner pressure, though personally I prefer the form B C d e as having more of character in it and showing in its form the reasoning that leads up to it.

On the assumption of rectangular teeth, it is seen that twice Bf is about four times l and so the teeth would have a breadth four times their length. This is a usual proportion with square-cornered teeth and these almost invariably break along B c showing that they are unnecessarily wide for their line of minimum strength. I have nothing new to add on the score of length, having found no reason for going back on the proportion I adopted several years ago, of making the length equal to half the pitch. It is now over twenty-two years since I first tried to have this done, but it was not until sixteen years after, that I found the opportunity of carrying it out, and then only in smaller gears, the use of large gears having so greatly diminished since the introduction of rope driving and later of electrical work.

In shrouding a wheel it is customary to consider that the tooth is strengthened, but this is doubtful. In Fig. 3, for example, the unshrouded tooth breaks along the line to d with a leverage Ak. Shroud it, however, up to the middle and it breaks along a line to c with a lever arm at half Ak. While the lever arm is halved so is the length along the line of break, and, so far as corner breakage is concerned, the tooth is no stronger for shrouding. But if this breaking corner is left off to begin with, the shrouding may be used to stiffen the tooth against breakage and pressure along the full line of the tooth face and this may be made use of to stiffen a narrow tooth such as lack of space sometimes renders it desirable to adopt. W. H. BOOTH.

* * *

TO PREVENT RUST ON SOLDERED ARTICLES.

Editor MACHINERY:

In your December issue, I note among "Odds and Ends for the Shop," some advice for the prevention of rust when soldering steel. This is all right as far as it goes, but in my opinion it does not go far enough. I somewhere obtained the idea of a process, which I now present to your readers and which I have found to fully neutralize the acid, something I was unable to satisfactorily accomplish with the process described in MACHINERY.

After soldering in the usual manner and wiping off all superfluous solder, boil the articles in a strong solution of sal-soda for a few minutes and then wash thoroughly with clean, hot water, and as soon as dry oil lightly while treating the lot to prevent rust. This may require an hour or more. Now expose the articles to a dry heat, in an oven, for instance, for ten or fifteen minutes, the heat being enough to give a good straw color to the bright steel parts. This heat is, of course, sufficient to remelt the solder, thus necessitating fastening the parts together other than by the solder alone. My work was of such a nature as to provide this. The final heating and a further light oiling, I have found perfectly successful, and no signs of rust showed on the inaccessible parts, even after several years. C. S. BEACH.

Bennington, Vt.

ABOUT INSERTED TOOL HOLDERS.

Editor MACHINERY:

Referring to the article by "Bell Crank" in the January number of MACHINERY, on the subject of inserted cutter lathe tools, possibly my own experience will give a little explanation for the reason these tools are found in so few shops. When these tools were first put on the market, or came to my knowledge, quite a number of years ago, they appeared to me as a great improvement over the forged tools, particularly as far as economy is concerned. I bought a half dozen of them and distributed them among what I considered my most progressive men, with instructions to call on me if they wanted more of them. Several months after, my attention was called to them, and I looked the matter up to find who had them in use, with the result that it was quite a hunt to find the original tools, and no one was using them. On questioning the workmen, I found they gave me no sufficiently good reason for dropping their use, and that they had hardly given them a fair trial. After another lapse of time, I visited a shop where they were in common use and satisfied myself that there was great economy in these tools, particularly in a shop like my own, where the men had at that time free access to the blacksmith, the result being that at most any time, I could find from two to four men waiting for the blacksmith to make or re-forge a tool. I also found that an inexperienced man would grind a tool but once or twice, before it must be redressed. I immediately purchased enough inserted cutter tools to supply every lathe and planer in the shop, and having learned wisdom by past experience, I put away in the tool room all the forged tools that these would replace, with instructions that for one month, as a trial, no forged diamond points or round nose should be given out. The result was that, after the first few days, there was no call for the forged tools and never has been since, and the same men who apparently condemned these tools on first trial would call for them now. Of course, they will not take the place of all forged tools, as some forms of tools must of necessity be forged, and in fact are better. This, perhaps, will account in a measure for the failure of many shops to use the cutter tools. The men do not have a chance to get thoroughly used to them.

F. H. N.

* * *

"In spite of all the good speeches which are made, it must be confessed that the average of oratory at technical meetings is low. There is, in general, no lack of speakers, and neither is there lack of knowledge; but it often happens that the men who speak do not know, and the men who know do not speak. In addition, we have the man both knows and speaks, but cannot express himself to any purpose." London "Engineering."

This may be true of those who speak at technical meetings, but the case is somewhat different for those who write for technical papers. The man who writes but does not know receives his manuscript back; the man who knows is generally not afraid to write, and the man who both knows and writes, but yet does not know how to write, has his manuscript corrected gratis by the editor. The moral is that all who know should write, even if not good writers.

* * *

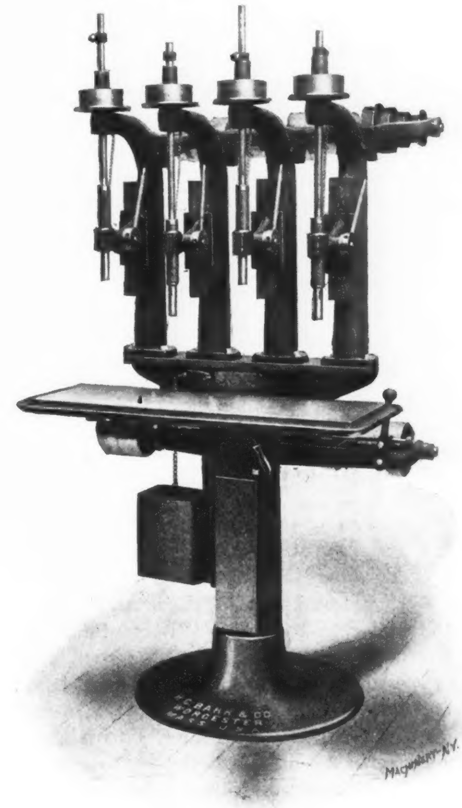
NEW SENSITIVE DRILL.

A newly-designed sensitive drill, having four spindles, is illustrated herewith. It is built by H. G. Barr & Co., Worcester, Mass., and has several new features for this type of machine.

The drill belongs to that class which has separate driving cones for each spindle, giving the usual range of speeds to each spindle independently. It is designed with a gap or throat where the table is generally used and for a vertical distance of 8 inches has a swing of 16 inches. Below the top of the table slide there is a swing of $14\frac{1}{2}$ inches. The driving cones run in a bracket cast in one piece and bolted to each post, thus increasing the rigidity of the posts. The cones are turned inside and out and run on a stationary shaft having an oil groove its entire length. The oiling is done through holes in the brackets between the pulleys, which makes a quick and positive means for keeping the pulleys lubricated. The counter cones are mounted in a bracket on the back of the columns on a shaft turning in babbitt bearings. These cones are also turned on the inside and the shaft is driven by tight and loose pulleys.

The table is large and is counterbalanced, which adds greatly to the convenience of the drill. It has a vertical traverse of 22 inches, giving a maximum distance of 33 inches between the spindle and the table. An oil groove $1\frac{3}{4}$ inches wide runs entirely around the table.

The spindles are made from forged spindle steel having a diameter of $\frac{7}{8}$ inch in the quill and provided with a No. 1 Morse taper hole. Fibre collars are provided at both ends of the quills



MULTIPLE SPINDLE SENSITIVE DRILL

and collars splined to the spindles between the upper fibre collar and the take up nut prevent the latter from changing when properly adjusted. The quills are provided with steel feed racks dowelled on and they are graduated, showing the depth of hole being drilled. The vertical traverse of the quill is $3\frac{1}{2}$ inches and the vertical adjustment of the head 8 inches. The heads are counterweighted and are clamped in position by handles instead of by the use of a wrench. Unlike the engraving, the feed levers pass clear through the collars, giving one end always in a convenient position. The belt-shifting device is quite novel and the drill is made with either two, three or four spindles, as desired.

* * *

SHOP TERMS ILLUSTRATED.

WORKING FIT.

MACHINE TOOLS, THEIR CONSTRUCTION AND MANIPULATION.—7.

BORING IN THE LATHE.

W. H. VAN DERVOORT

A large portion of the work done in the lathe may be classed as boring work as it comes under the following classifications: center rest, carriage, face plate and chuck work. An example of a boring operation under the first class was shown in Fig. 54, article 6. As work of this kind is usually performed on solid stock, a hole must first be drilled sufficiently large to allow the boring tool to enter. The drilling of this hole can be done to good advantage in the lathe by using a twist drill held on the tail center. The taper shank drill with holder, shown in Fig. 58, is best suited to this work as it clears itself readily of the cuttings and the holder prevents injury to the shank. In no case should the taper shank drill be held by a dog secured on the shank, as it is quite certain to slip and injure the tool. If a dog is to be used at all for this purpose, it should be in connection with a straight shank drill provided with a flat spot on the shank for the set-screw of the dog to seat upon. When considerable drilling of this kind is to be done in a lathe, it is advisable to have a set of drill sockets fitted to the socket in the tail spindle. This not only makes a more satisfactory method for holding the drill, but overcomes the danger of the drill drawing off the tail center and being bent or broken by the cramp it would receive due to the single-handed holder.

When holes of a considerable depth are to be drilled in this manner in steel, it is difficult to properly lubricate the cutting edges of the drill, and often the work and tool begin to heat and the cuttings to fill up the flutes. The drill must, therefore, be frequently removed for oil and cleaning. These difficulties are almost wholly overcome by using the oil tube drill in places of this kind, as it provides for a constant and liberal supply of oil at the point, and this not only improves the cutting and clearing of the chips, but carries away the heat of friction and thus enables the crowding of the drill to its full cutting capacity. As in this class of drilling the drill does not rotate, a common socket can be used in connection with the oil tube drill, it being simply necessary to tap for a small gas pipe connection with the side of the socket over the supply hole in the shank of the drill. In an operation of this kind the important point is to get the drill

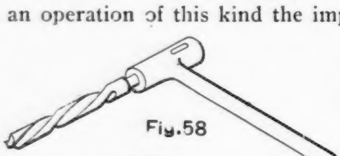


Fig. 58


Fig. 60

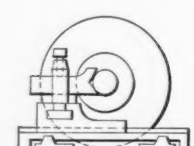


Fig. 59

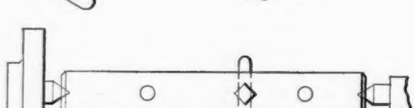

Machinery, N.Y.

Fig. 61

started true. If the work has been centered for other operations previous to the drilling, this center forms a seat for steadying the point of the drill in starting. Even though this center runs perfectly true, it cannot be relied upon for starting the drill true. It is, therefore, necessary to steady the end of the drill in a different manner. In Fig. 59 is shown a common method. The steadying tool, which is held in the tool post, is made to bear against the front side of the drill, as close to the point as possible. The drill should be held so that one lip is on the back side of the work surface or opposite the steadying tool. As the cut is started, the drill is crowded slightly back of the center, making the one lip do all the cutting. This makes it virtually a rigid boring tool that cannot sway and produces a surface concentric with the axis of rotation. Just before the drill begins to cut a full diameter hole, the steady tool should be backed away and the point of the drill left free to follow the center of rotation. If this work is carefully performed, it is possible to start a drill almost exactly true. When the surface into which the drill is to enter is plane, the centering tool with flat drill point shown in Fig. 60, and held in the tool post, is used. It forms a good seat for the drill to start in.

For uniformly true and central holes the drill cannot be relied upon, and its use in the lathe is confined almost entirely to the opening up of the work previous to using a boring tool. For example, if a 1" hole is required in a piece of work held on a face plate or in a chuck, a 1" drill could not be depended upon for anything like a satisfactory result and a 63-64" drill followed by a 1" reamer would be almost as bad. The only correct way in such a case would be to first use, say, a 15-16" drill which would remove most of the stock and allow a boring tool to enter. It can then be bored with the boring tool to within the proper diameter or, if it is to be finished with a reamer, it should be bored to within about 1-100 of an inch of the exact size, which trues the hole perfectly previous to the reaming. The reamer should be held on the tail center which latter must be exactly central. If the tail center is offset, a tapered hole will necessarily result.

The size of drill to use for opening up previous to boring depends upon the nature of the work. If the finished hole is to be small in diameter and deep, a drill as large as possible should be used, since the boring tool will be a long and springy one

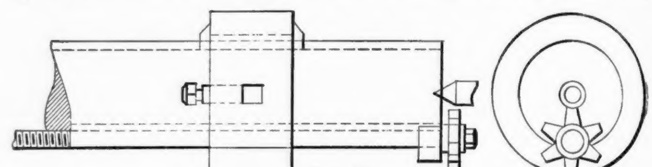


Fig. 62

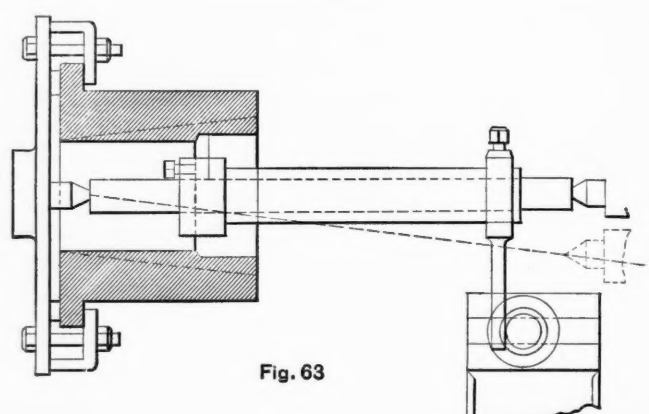


Fig. 63

Machinery, N.Y.

necessitating light cuts which will remove the metal more slowly than would the drill. If, on the other hand, the hole is to be of large diameter and not deep, a drill should be used that is only large enough to enable a short, stiff boring tool to readily enter, as the boring tool will remove the stock faster than the drill would. In using the boring tool, it is generally well to feed both ways through the work as this tends to equalize the effect of the wear on the cutting edge. In cases where accurate bores are required, it is quite necessary not to change the depth of cut after the cut has started, as the effect of the spring of the tool will be quite marked. A boring tool tends to make the mouth somewhat larger than the balance of the hole it is boring, because the tool does not take its full spring until the cutting edge passes the end of the base.

In the boring of parallel holes, the height of the cutting edge does not affect the parallelism of the bore. With tapered bores, however, it is necessary that the tool set at the height of the center, as a different taper than the one required would result if the cutting edge were above or below the center. The amount of taper in either case would be somewhat smaller than when the cutting edge is at the center. When the bores are long and of large diameter, the boring tool is no longer well suited to the work and what is known as a boring bar is used. These bars are of two kinds, those having a cutting tool fixed in its position on the bar, and those in which a cutting tool is screwed in a movable head which traverses over the bar. The former are the least desirable, inasmuch as they must be somewhat more than twice the length of the bore, while, with the latter, a length but slightly greater than the bore is all that is required.

In Fig. 61 is shown a plain boring bar of the former type. The cutting tool may be of flat steel screwed in a mortice through the bar by suitable wedges, or it may be, as shown in the figure, of round steel, fitting nicely the hole through the bar and screwed

in position by a set-screw which seats on a flat spot fixed on the tool. The set-screw should have a smooth, flat point so that, when moderately tightened, the tool can be driven under it in adjusting the cut. This class of boring bar is suitable only on work screwed to the carriage, as the work must be given the feed over the cutting tool. In Fig. 62 is shown a traverse head boring bar. A tool-carrying head fits nicely upon this bar. It is splined to receive the key which is screwed in the head. The feed or traverse of the head is accomplished by means of a screw usually driven by a star feed from one end. When the bar is of large diameter as compared with the head, the screw can be dropped into a suitable spline, thus getting it out of the way and protecting it from injury. Boring bars of moderate size are preferably made of a medium grade of tool steel, as this is much stiffer than mild steel. For large bars, mild steel or cast iron is suitable. When cast iron is used, the ends should be plugged with steel to receive the centers, as the cast iron wears too rapidly to retain an accurate center bearing. Movable head boring bars, in which the head is traversed by means of the regular carriage feed, can be used to good advantage in cases where the bar remains stationary and the work rotates. In Fig. 63 is shown a movable head bar of this class operating upon a cylinder secured to the face plate. The bar carries a long sleeve, one

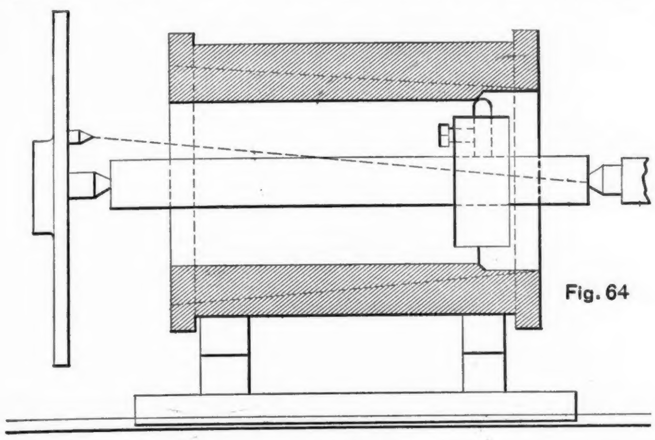


Fig. 64

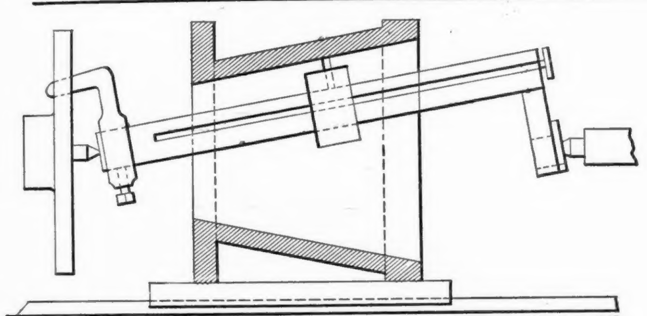


Fig. 65

end of which terminates in the cutter. A dog or wrench screwed to the outer end of the sleeve prevents it from turning and the tool post bearing against the arm of the dog transmits the regular carriage feed to the tool. By off-setting the tail center as shown by the dotted line, a tapered hole results which will be larger at the inner end of the bore, with the tool set as in the figure, but if the cutting tool is set at 180 degrees from the position shown, the bore will be larger at the outer end, as indicated by the dotted lines.

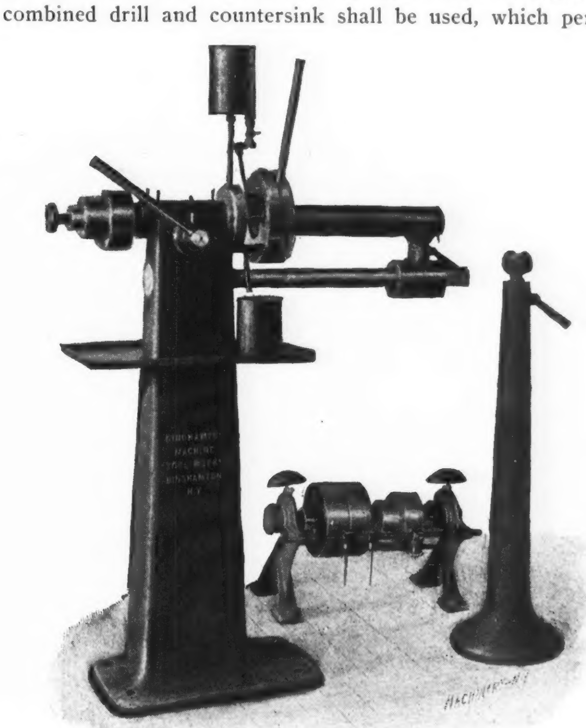
Unless the character of the work is such as to enable its outer end to be run in the center rest when the bore is long, rotating the work is not satisfactory, as its outer end is too far from the lathe spindle to be sufficiently rigid. When the work is clamped to the carriage, it is always preferable to feed the cutting tool rather than the work as the carriage can then be clamped rigidly to the bed. This insures a more accurate bore as the carriage, unless very closely gibbed, will lift on the up cut of the tool.

In Fig. 64 is shown a movable head bar operating upon a cylinder clamped to the lathe carriage. In this case, off-setting the tail center as the bar rotates will not enable the boring of a tapered hole. The tapered hole, however, can be obtained by off-setting one end of the boring bar as shown dotted in the figure. If desired, the offset can be put on the bar itself, in which case it can, as shown in Fig. 65, be offset at the tail center end. By making the center bearing adjustable, as seen in the figure, any desired taper within the limits of its adjustment may be obtained. In boring work, it is very important to see that the work is properly secured on the carriage, face plate or in the chuck. It must be held sufficiently rigid to prevent its working loose and, at the same time, must not be sprung out of shape as, in such cases, when finished and removed from the lathe, it will be found out of true. In straight cylinder boring, more than one cutting tool is usually employed as a single cutter springs the bar, thus requiring very light finishing cuts to produce satisfactory results. Three cutters steady the bar nicely, especially if care is exercised in setting the cuts about equal. A tool for finishing should not follow a roughing cutter, inasmuch as all the springing of the roughing cutter, due to its unequal work at different points of the bore, will be transmitted directly to the finishing cutter and thus produce an untrue cylinder. To insure true work, the finishing cuts should always be light ones.

* * *

CENTERING MACHINE.

The accompanying illustration shows a new design of centering machine which is intended to center work from $\frac{1}{4}$ to 3 inches in diameter and of any length. The drill chuck is of special design and is held entirely within the spindle of the machine. The chuck for holding the stock is so located that the work is brought as close as possible to the spindle, making a rigid arrangement for centering stock accurately and especially adapting the machine for centering accurate, finished stock. This chuck is a universal scroll chuck with hardened jaws ground true. The outer end of the work is held by a graduated adjustable rest, which slides on the support bar of the machine. For very long pieces an adjustable rear support is provided which can be placed at any distance in the rear of the machine. It is intended that a combined drill and countersink shall be used, which performs



CENTERING MACHINE.

both the operations of drilling and countersinking at once. The drill is held in such a manner that only as much projects beyond the end of the spindle as is used for centering, which makes it possible to center stock that has not been squared up and is either rough on the end or is beveled. A positive stop is provided and any number of pieces can be centered to a uniform depth. The spindle has a convenient lever feed and provision is made for oiling the drill. Each machine is furnished with two drill sockets, one dozen assorted combination center-drills and all wrenches and fixtures required to operate the machine, together with countershaft. The machine is the product of the Binghampton Machine Tool Works, Binghampton, N. Y.

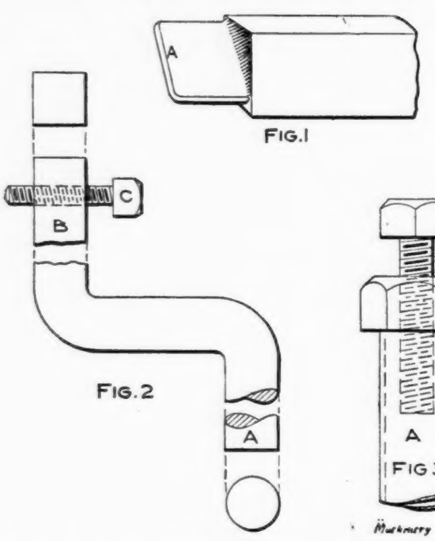
SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

SOME LATHE AND PLANER KINKS.

Mr. Edward G. Haddix, Burlington, Iowa, sends sketches with descriptions of some useful lathe and planer tools and attachments. Fig. 1 is a finishing tool for planers, which may be used on either steel or wrought iron without water and leave an excellently finished surface. The tool is forged from ordinary stock, but the cutting portion is made diagonal to faces of stock so that when used the edge A operates with a shearing action. Mr. Haddix states that the cutting edge should be ground with a lip and the end rounded slightly, so that only a small portion of the end will bear on the work, but we believe



the practice, where these tools are used, is, in some cases, to make the tool with the cutting edge perfectly straight and merely round the corners slightly. Planer tools made on this principle require great care in the setting to obtain good results, and must also be ground accurately, but the surfaces obtained are well worth the trouble.

A planer dog or jack is shown in Fig. 2, which is made with the end A of round cross-section and the end B square. The round end may be stuck into a hole in the planer platen, and the screw C in the other end used against the work being planed. Fig. 3 is a planer jack that can be quickly made from a section of gas-pipe, a screw and an ordinary nut. The sketch makes everything clear. Although very simple, it is, however, handy to have around the planer.

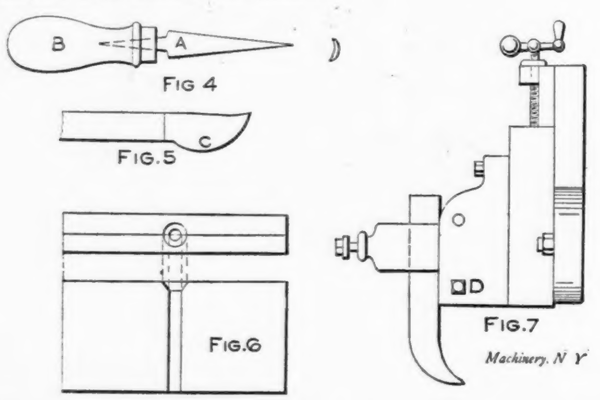


Fig. 4 shows a cheap, effective, home-made belt punch consisting of a piece of taper tool steel A, one side of which is concave and the other convex. It is sharpened on the point and on the two edges and can easily be made out of a small half-round file. B is a common file handle into which A is fitted. To use this punch, stick it into the belt and give it a twisting motion, pushing it farther in all the while. As the blade is tapered, various sizes of holes can be made. It is also useful in removing old laces.

Fig. 5 represents a heavy cutting-off tool used for cutting large shafts and bars. It is made in the usual manner except that there is more metal in the thin part, bringing the edge C below the line of the shank of the tool. When it is being used, a small jack is set on the cross-slide of the lathe carriage, and this blocks up the portion marked C, thus adding to the stiffness of the tool.

We had some countersunk head rivets to make out of copper wire and found it difficult to hold the wire until a head could be formed. This is the way we overcame the difficulty. A couple of pieces of ½"x1½" flat-iron were procured, clamped together and drilled so that the hole came in each piece, as in Fig. 6. Then the hole was countersunk, the wire was held between these plates, which in turn were held in the vise and the rivets were made quickly.

Oftentimes in planer work, the tool, when at the end of a stroke, will break out a large piece of metal. This usually happens when the cast-iron is dirty, and in order to prevent this, a man will have to score a line with a hammer and chisel. Even then it is not always a good job, and it takes considerable time. Fig. 7 is a planer head, having a small hole about ⅝" tapped in the side through to the apron, as shown at D in the sketch. This hole is fitted with a set-screw, having a flat point, which will keep the apron from moving. A tool something like the one shown can then be used for scoring a line by running the head back and forth a few times with the point of the tool against the work.

It is sometimes desirable to have a stepped washer for the tool-post of a lathe, but sometimes trouble is met in attempting to make one. The accompanying sketch, Fig. 8, shows the method to be employed when laying one out for the shaper man. The circumference is divided into eight parts and numbered from one to 8. Each of these divisions is then bisected and lettered from A to H. Lines are drawn, as shown, from 1 to E, from 2 to F, from 3 to G, from 4 to H, from 5 to A, from 6 to B, from 7 to C and from 8 to D. The lines to be followed on the shaper are the ones that are drawn in full. The steps or spaces are of the same shape and size.

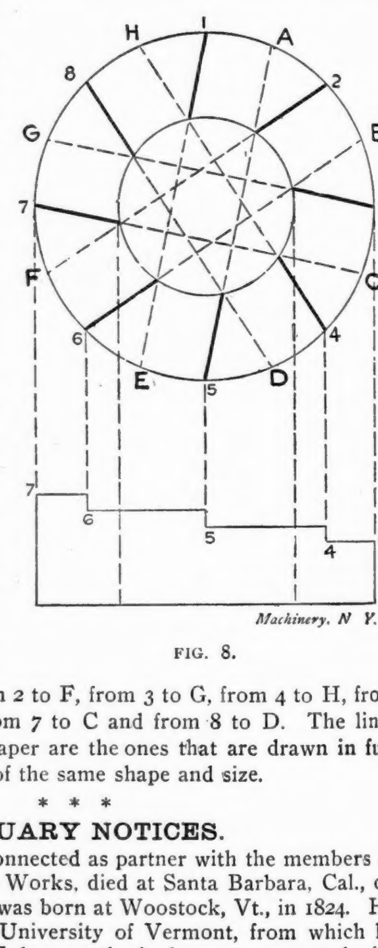


FIG. 8.

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OBITUARY NOTICES.

Dr. E. H. Williams, connected as partner with the members of the Baldwin Locomotive Works, died at Santa Barbara, Cal., on December 21, 1899. He was born at Woostock, Vt., in 1824. He studied medicine at the University of Vermont, from which he was graduated in 1846. Subsequently, he became connected with various railroad companies, among others the Michigan Central Railroad. In 1870 he became a partner in the Baldwin Locomotive works and traveled extensively in the interests of that firm, of which he was still a member when he died.

Mr. Theodore Alteneder, Sr., of the firm of Theodore Alteneder & Sons, manufacturers of drawing instruments, died recently in Philadelphia, aged 78 years. Mr. Alteneder's inventions and improvements have made his name familiar to the engineering profession.

Mr. Samuel Dana Greene, assistant general manager of the General Electric Co., Schenectady, N. Y., was drowned with his wife while skating on the Mohawk River. He was the son of Commander Samuel Dana Greene, U. S. N., and was one of the foremost men of Schenectady and well known all over the state. Mr. Greene was for some years chief engineer of the Sprague Electric Railway and Motor Co. His wife was a daughter of Rear Admiral Chandler, U. S. N.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

34.—H. W. R.: Do you know of any practical way of soldering aluminum?

A.—The answer to this question was taken from the catalogue of the Pittsburg Reduction Co.

Good joints can be made by carefully cleaning the surfaces to be joined and, with very hot soldering bits or careful work with the blow pipe, "tinning" the surfaces with some of the special solder used, before attempting to join the surfaces of the metals, using special alloys for the solder. Several such solders are successfully used, pure tin with a little phosphor tin being the basis of the majority of such solders. Soldering bits of nickel are best, however, and specially good work has been done with those kept hot by a gasoline torch or electric appliance.

Special care should be taken to clean the surfaces to be soldered. This can be successfully accomplished by the mechanical means of scratch-brushing, scraping or filing the surfaces, thus exposing fresh metal free from the thin film of oxide of aluminum and the oxide of silicon (silica) which forms a retentive and protecting coating over the surface of the metal, preventing either the soldering or plating of the aluminum.

Another way to clean the surface of aluminum, for either soldering or plating, is to dip the sheets into nitric acid diluted with three times its bulk of hot water and which has just enough hydrofluoric acid added to it to make the solution act on the surface of the metal, this action being denoted by the evolution of gas bubbles. The solution can be kept in either wooden or lead lined tanks, and the amount of hydrofluoric acid added need be only small, say less than five, or at most, ten per cent. of the bulk of the solution. The hydrofluoric acid required is the cheap fluid of commerce sold in lead jugs and costing five cents per pound.

The aluminum, after being cleaned in this diluted nitric and hydrofluoric acid solution, is again dipped into hot water for rinsing and dried in hot sawdust. It is then cleaned so that either soldering or plating solutions can be readily applied.

35.—M. L.: Please tell me which is the correct way to set the tool in threading a taper piece—with the center line of thread tool at right angles to the surface of the work, or at right angles to the axis of the work.

A.—The accepted method, as reported by the committee of the American Society of Mechanical Engineers, appointed to report upon standard pipe threads, is to set the axis of the tool at right angles to the axis of the work. This practice is commonly followed by tap manufacturers. On steep tapers threads cut in this way have greater holding power. On ordinary tapers it makes little or no difference which method is adopted.

36.—A. D.: There is an argument in our shop about punching steel of the same thickness as the diameter of the punch. Can this be done, and if so, how much thicker than this can a punch penetrate? One man claims that 12 inches of steel have been punched at once by a punch one inch in diameter.

A.—Our contributor, Mr. J. L. Lucas, who has given much attention to punching machinery, writes us with regard to this question: "The punching of 2½ inches of steel by a one-inch punch is the best that I have any record of and I do not think that 12 inches of either iron or steel can be punched by a one-inch punch under any conditions."

37.—We have received two inquiries from foreign correspondents, one about a pyrometer known as "Hobson's Pyrometer" and the other with regard to hardening Bessemer steel or Homogene.

A.—We are unable to obtain any information about a pyrometer by this name and must refer the question to our readers. With regard to hardening the steel, Mr. Maunsel White, engineer of tests, Bethlehem Steel Co., writes: "We do not know of any special process for hardening Bessemer steel or Homogene. The presence of carbon is essential to hardening and it can be very readily aided by means of cementation."

38.—W. H. M.: 1. What metal expands the most? 2. How much would a hollow cylinder of this metal expand, if it were 1" × 1" × 3/16" shell? 3. How can I calculate the size of a steam engine (without the use of a formula) to drive an air compressor or any given machine?

A.—1. Of the common metals, lead and zinc; and as far as we know their expansion exceeds that of any metal. Aluminum expands nearly as much. 2. The coefficient of expansion is about .000015 for each degree Fahr. The temperature of a gas flame would probably not be far from 1000 degrees, although we know of no tests showing just what it is. The expansion of a hollow cylinder depends upon the expansion of its diameter and not the expansion of its area. Hence this cylinder would increase about $940 \times .000015 \times 1 = .014$ inch, assuming the temperature at the start to be 60 degrees. 3. To determine the size of a steam engine we must know the power it is to develop, the number of revolutions it is to make, the mean steam pressure in the cylinder and the relation between the length of stroke and the diameter of cylinder. The mean steam pressure will depend mainly upon the boiler pressure, the point of cut-off and the amount of compression. In the computation the area of the cylinder must be taken in inches and the length of stroke in feet. The relations between all these quantities are complex and can be much more easily found by the aid of formulas, which are quite simple and which we should advise you to learn to use. In fact, we could not well spare the room necessary to explain the question without the aid of a formula. The simple formula for the horse power of a steam engine is

$$H = \frac{2 \times P \times L \times A \times N}{33{,}000}$$

where H = horse-power, P = mean effective pressure, L = length of stroke in feet, A = area of piston in inches, N = revolutions per minute. For your particular problem this can be reduced to the form,

$$L \times A = \frac{16{,}500 \times H}{P \times N}$$

That is, the length of stroke in feet, times the area of cylinder, equals 16500 times the horse-power, divided by the mean effective pressure times the number of revolutions per minute. Your main difficulty may be in determining the mean effective pressure and for a rough estimate this may be taken at half the boiler pressure.

39.—L. M.: 1.—What is the rule to find the angle of a tool for cutting very coarse square threads? 2.—Please outline a course of study most likely to benefit a toolmaker. 3.—Will you not publish something upon die construction and mechanical drawing?

A.—We did not notice, until too late for this issue, that your first enquiry needs a sketch. We will, however, try to explain the subject without a drawing. First, compute the circumference of the screw at the base of the thread, by multiplying the diameter at the base by 22 and dividing it by 7. Draw a straight line, which we will call a b, equal to the length of this circumference. From point a at one end of the line, draw another line at right angles to it of a length equal to the pitch of the screw. Connect the outer end of this second line with point b of the first line, making a right-angled triangle. This last line gives the inclination of the thread, and the side of the tool should have a little more clearance or inclination than this line. 2.—A toolmaker should try to lay a good foundation on which he can build with future knowledge from whatever source it is to be obtained. To this end he should know enough mathematics to understand the articles in the technical papers, and we can recommend for this purpose "Mathematics Self-Taught," which is noticed in another column of this number. It would be well to procure the book on the milling machine published by the Cincinnati Milling Machine Company, and by the Brown & Sharpe Manufacturing Company, as well as the books on grinding machines and gearing published by the latter firm. Other subjects that would be of value are elementary mechanics, mechanism and mechanical drawing, and the subject of steel. There are several excellent books upon all of these, which we shall be pleased to name, if desired. A toolmaker needs to be a close student of the ways and means of doing shop work, and hence should be a close observer and a careful reader of the mechanical papers, and

lacked the time and possibly the knowledge necessary to make a it would also be well to study the different catalogues as they appear. We know of no good book treating strictly of tool making. 3.—We shall be pleased to receive material upon die making from any reader of MACHINERY who has had experience in this line of work. A complete series upon mechanical drawing was published in the second volume of MACHINERY.

40.—Clayton: 1.—How much oil does it take to produce 1 H.P. in an oil engine? 2.—How much gas does it take to produce 1 H. P. in a gas engine? 3.—How do they calculate that air is compressed to 35 atmospheres as in the case of the Diesel motor? 4.—Is this type of motor more economical than any other?

A.—1.—Tests of a number of oil engines of 10 or 15 H. P. show oil consumption of from ½ to 1½ pounds per H. P. hour. 2.—Small gas engines use from 25 to 30 feet of gas, medium sized gas engines, 18 to 25 cubic feet, and large engines from 12 to 18 cubic feet per H. P. hour (indicated). 3.—When a gas of known volume is compressed to a smaller volume, its temperature and pressure rise according to certain known laws and they can be approximately calculated. The formula that would apply to the Diesel motor is:

$$\frac{v}{V} = \left(\frac{P}{p}\right)^{1.41}$$

where v, p are the volume and pressure at the beginning of compression and V, P are the volume and pressure at the end. To compress to 35 atmospheres would probably require that the air be compressed to about 8-10 of its original volume. This formula requires the use of logarithms in its application. 4.—The Diesel motor is said to operate on about 4-10 pounds of oil per H. P. hour.

41.—A. H. I.: Could you give the best method of magnetizing a piece of tool steel? The piece is small, about 3 inches long and ¾ inches square, and is for experimental purposes. I have attempted to magnetize it in several ways, but it takes very little, merely enough to pick up a small needle, and it seems that I have not the right temper in it.

A.—The best way to magnetize a piece of hardened steel is by means of an electric current passed through a coil of wire wound around the bar. Make a spool, about the length of the bar, and of sufficient diameter to hold about 1000 feet of No. 20 B. & S. cotton covered magnet wire. Take a piece of bar iron about one inch square and bend it into the form of a U and of such size that it will span the coil and pass over the ends of the steel bar, so as to form a closed loop with the steel. Pass through the coil a current derived from the wires leading to an incandescent light socket. Do not allow the current to pass through the coil for more than two or three seconds or it will burn it out. After the current has been cut off, remove the U bar and take out the magnet, and if it is of the proper kind of steel and suitably tempered, it will be well magnetized. Any good quality of tool steel will make a strong magnet, although some kinds are better than others. Chrome steel is very good. The bar should be hardened in ice cold brine, and then it should be drawn to a very light straw color.

42.—G. E. R.—I am running an Eddy generator of 15 K. W. capacity, which gives an e.m.f. of 125 volts and current of 120 amperes. When the machine stands still for 10 or 12 hours, it sparks badly on starting up, then after a few minutes it runs all right until it stands still again. The commutator is a little rough and I cannot keep it smooth. The machine is run at 110 volts and the ammeter stands at 128 amperes, and when I put on all the lights, the brushes have to be moved forward. I would like to know how to stop the sparking and also whether it will do to add 20 more lights, of 16 candle power each.

A.—When the generator stands still for some hours, dust collects upon the surface of the commutator, and as it is not very smooth, this dust does not rub off readily, hence, the sparking is increased in starting, until the dust is removed by the rubbing of the brushes. There is evidently nothing the matter with the machine, and the only way to reduce the sparking is by moving the brushes back and forth until the position is found in which they make the smallest spark. In this way the surface can be kept smoother, for the smaller the spark the less it is roughened up. Theoretically, the brushes of all generators have to be advanced as the strength of current increases, but some generators are so proportioned that the amount of shifting required is so small as to amount to nothing, practically, unless the machine is greatly overloaded. As to the advisability of adding 20 more lamps, we can only say that a machine of the size given should be able to carry 240 to 250 16-candle lamps at full lead, and an increase of 20, which would be less than ten per cent., should not overtax it. On general principles it is not good policy to overload machines, because one is likely to wind up by following the practice of street car conductors who always believe there is room for one more. Thus if you start by adding 20 lamps you may next try the experiment of increasing the number by ten, and then another ten, and so on until the generator breaks down under the load.

* * *

NEW TOOLS OF THE MONTH.

Under this heading are listed the new machine and small tools that have been brought out during the preceding month. Manufacturers are requested to send brief descriptions of their new tools as they appear, for use in this column.

Chicago Flexible Shaft Co., Chicago, Ill. A gas blast furnace which combines a complete outfit for hardening, tempering and annealing dies, taps, reamers, drills and similar tools.

National Die Stock Co., Cleveland, Ohio. A die stock that contains some convenient features. It is adjustable and has a quick-acting motion for opening the two-part die.

Carter & Hakes Machine Co., Winsted, Conn. A plain milling machine that contains a number of valuable features. Has reversed cone pulley so that additional strength is obtained in the frame supporting the work spindle.

William H. Warren Machine Tool Works, Worcester, Mass. A 4½ foot semi-universal radial drill of extremely heavy pattern. Contains some features not possessed by the older models.

J. L. Cook, Springfield, Ill. A drill socket made so as to prevent the twisting off of shanks that is so common with the ordinary type.

Marshall & Huschart Machinery Co., Chicago. A circular saw for machine shops, intended to take the place of the older style power hack saw.

Fellows Gear Shaper Co., Springfield, Vt. Improvements in the 36-inch Fellows gear shaper.

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FRESH FROM THE PRESS.

The Mechanical World Pocket Diary and Year Book, for 1900. Thirteenth year of publication. Published by the "Mechanical World," Manchester, England. Price in England, sixpence.

This book has 244 pages, pocket size, and contains a collection of engineering notes, rules, tables, and other data, and is one of the better known handbooks. As it is quite small and compact it covers the field of mechanical engineering only in a limited way, but at the same time it is a useful book and treats, among other subjects, of steam and the steam engine, the steam engine indicator, slide-valve diagram, gas engines, boilers, safety valves, strength of materials, gearing, rope driving, and has numerous tables upon various subjects. While the book does not cover the same ground, it is of about the size and grade as that issued by the International Correspondence Schools in this country. It is devoted more strictly to engineering and mechanical matters than the latter.

Fowler's Mechanical Engineers' Pocket Book, edition of 1900. 500 pages, illustrated. Edited by William H. Fowler, and published by The Scientific Publishing Co., Manchester, England. For sale by D. Van Nostrand Co., Murray street, New York. Price $1.00.

We have been favored with a copy of this work by both the publishers and their representatives in this country. The first edition of the pocket book was noticed in these columns when it appeared a year ago, and this new edition is increased to nearly twice the size of the former one. To give an idea of its scope it may be said that it is larger and treats of more subjects than the "Mechanical World" pocket book, mentioned above, but that it is not as complete as Low's pocket book, which is a well known English work. It also treats less of design and more of general principles. It is made up largely of bits of valuable information about engineering that have been obtained from various sources and treats of some subjects, like textile machinery, for example, that most hand-books are silent upon.

Power Transmitted by Electricity, by Philip Atkinson, A.M., Ph.D. Published by D. Van Nostrand Co., 23 Murray and 27 Warren streets, New York. 241 12mo pages, illustrated. Price $2.00.

Mr. Atkinson has written several books upon electrical subjects that have been of value to the reader desiring a general and somewhat superficial knowledge of the subject, but who

thorough study of it. The present volume is a complete revision of a book written by the author several years ago upon the transformation of power and it has been his aim to bring it up to date in all respects. As stated, it does not go into the subject deeply, but treats in a popular, but we believe in an entirely accurate, manner of the electric motor, for both stationary and railway work, and central station construction and equipment.

Standard Polyphase Apparatus and Systems, by Maurice A. Oudin, M.S. Published in England and for sale by D. Van Nostrand Co., 23 Murray and 27 Warren street, New York. 250 pages, illustrated. Price $3.00.

This book seems to fill a corner in the field of electrical literature that will be appreciated by the student and the practitioner alike. The increasing use of the alternating current has made it necessary for those connected with the electrical industry to become informed as far as possible about its operation. There is much literature upon the subject, but it is generally of an intensely mathematical character and there has seemed to be no available information in a more popular style. The author states that his work is for those who operate or are interested in polyphase machinery and that while a general acquaintance with alternating current machinery and apparatus is presupposed, he believes that those who have had experience only with direct current machinery will be able to understand his work. The book is not so elementary as those of Mr. Atkinson's mentioned above, but belongs rather to that class that stands between the popular treatment and the mathematical treatment found in the most advanced books.

Mathematics Self-Taught. Arithmetic and Algebra. Adapted from the German of H. B. Lubsen, by Henry Harrison Suplee, B.Sc. Published by the author, 120-122 Liberty street, New York. 338 8vo pages. Price $2.00.

The subjects of arithmetic and algebra are here treated by methods that are quite different from those adopted by American authors in their school text-books. It is less abstract and the steps are more fully explained, with the evident intention of leading the student step by step to a complete understanding of the subject. The section on arithmetic is confined strictly to its subject and does not contain matter, like mensuration and other topics, that properly come under the heading of geometry or other branches of mathematics. The Lubsen method is to be commended in several respects. For example, the student is led almost unconsciously from arithmetic to algebra and he finds himself working with literal factors instead of numerals without realizing that he is doing anything outside of the realm of ordinary arithmetic. The same is also true when the subject of logarithms is taken up. Hrere the student finds a simple explanation of how calculations can be simplified by tables of exponents, which are really logarithms, and when he is convinced that this can be done, he is ready to take up problems in logarithms with an understanding of the basis on which they are worked.

While the subject matter is presented clearly, the book is not elementary in the sense of being incomplete or only adapted to the use of younger pupils. Sufficient ground is covered for practical purposes and of the two the work is better suited to adults who wish to become more proficient in mathematics than to young beginners. Many examples are worked out to show the process of applying arithmetic and algebra to actual work. Some of these examples have a very practical bearing in mechanics. The book abounds in interesting features that will be best appreciated, perhaps, by those who are accustomed to the usual text books. One of these is a simple approximate method for extracting roots, and another is the explanation of why operations are indicated and not performed in algebra.

To learn mathematics, like any other difficult subject, requires, first, a student who is studiously inclined and is accustomed to study, and a great deal of time devoted to the subject. It is as much a trade to be able to sit down and master a book as to perform a good piece of machine work. If one is studiously inclined, we believe that he can learn a great deal about mathematics from this book, and we can recommend it to such a person for home study, without a teacher.

ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9x12, 6x9 AND 3½x6 INCHES. THE 6x9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

John D. Watkins, 9-15 Murray street, New York, has issued the 1900 number of the Bradford Diary which is intended for pocket use. It is an attractive little book and, for those who do not wish to keep a diary, it serves as an excellent daily reminder.

The Grant Machine Tool Works, Cleveland, O. Catalogue of machine tools and of steel balls and screw machine products made by the Grant Ball Co.; 32 pages illustrated.

This company is gradually adding to the list of tools that it makes, one of the latest additions being a 44" turret and chucking lathe. There are also several small machine parts illustrated, like a compound rest, milling machine vise, etc.

The Standard Tool Co., Cleveland, O. Catalogue of twist drills, reamers, taps, etc.; 79 pages illustrated.

The well-known line of small tools made by this company has been added to during the past year, making the list of their products and the variety of sizes and styles more complete than ever before.

W. H. Nicholson & Co., Wilkesbarre, Pa. Catalogue of expanding lathe mandrels, 18 pages illustrated.

The utility of these expanding mandrels for lathe and milling machine work is well known, and the catalogue gives full information about the different sizes and styles in which they are made and their use.

H. H. Franklin Mfg. Co., Syracuse, N. Y., have issued a small catalogue that shows in an attractive manner some of the numerous castings that they make to take the place of parts that are ordinarily machine finished. The process used by this company is said to be such that screw threads and other parts can be cast which are as good for many purposes as the same parts finished by machine.

Prentiss Vise Co., 44 Barclay street, New York. Catalogue of vises, 48 pages illustrated.

The numerous styles of vises made by this company are listed in this catalogue and include, besides their numerous types of machinists' vises, many special designs.

The Billings & Spencer Co., Hartford, Conn. Catalogue of improved dropped hammers, trimming presses and forges; 36 pages illustrated.

Drop hammers ranging from 3000 pounds weight of drop to a 400 pound hammer are listed, and photographs are shown of numerous drop forgings regularly made by this company.

MANUFACTURERS' NOTES.

It is the evident intention of the Joseph Dixon Crucible Co., Jersey City, N. J., that if the work of the editor for the coming year is of an inferior quality, it shall be through no fault of theirs. With their customary generosity they have presented us with a varied assortment of pencils and erasers for the New Year. These, it is needless to say, are of superior quality, and, if the tools could make the man, or more properly, in this case, the periodical, the readers would join with us in extending thanks to the well known makers of these excellent pencils.

The International Correspondence Schools now announce that they have over 130,000 students and that their courses number over 70.

The B. F. Sturtevant Co., of Boston, Mass., report an increase of nearly 40 per cent. in the volume of their business for 1899 over that of the previous year.

During the past year an addition covering 20,000 sq. ft. has been made for the use of the electrical department, which although completed a few months ago, is, they say, already overcrowded. They also report numerous special orders for electric fans and special generating sets for the Navy Department, and the construction of a complete line of enclosed motors of new design is now under way.

The old method of running belts tight has been so long forced upon engineers that they are often slow to realize that slack belts, carrying full load and running free of initial tension yet never slipping, are not only a mechanical possibility, but an actual condition seen in shops of the customers of the Cling-Surface Mfg. Co., Buffalo, N. Y., whose business about New York has necessitated the opening of a branch office in that city, in the Postal-Telegraph Bldg., 253 Broadway.

The Waltham Watch Tool Co., Springfield, Mass., have recently added to their works a new shop about 25,000 square feet, which is about three times the area of their old shop.

Mr. Charles A. Moore, of Manning, Maxwell & Moore, New York City, sailed on Tuesday, January 9, for Mediterranean ports and Egypt. The trip is said to be purely one of rest, and no business is to be connected with it.

The Pedrick & Ayer Co. have sent fifty-two of their belted shop air compressors abroad during the past year.

The Newton Machine Tool Works have made an addition to their present shop to accommodate their increasing business. The addition will make a shop 100' by 222'.

The Stow Flexible Shaft Co., of Philadelphia, had recently a request from one of the largest fruit growers of Southern California, for an equipment of their flexible shafting so arranged as to be of value attached to a motive power, for tree trimming. Mr. Frederick Schoff, proprietor of this company, at once set about making such equipment, and reports evidence of much success therein. They also report a large increase of orders for their portable air motor.

The Sprague Electric Co. of New York have just received an order for sixteen motors to be used in running the presses and machinery in a lithographing establishment in Tokio, Japan. It will be one of the finest equipped plants in Japan and will be operated under the supervision of a Japanese expert who is now in this country gathering ideas.

CALENDARS.

We have received from the Standard Welding Co., Cleveland, O., a calendar and memorandum book which calls attention to this company's electrically welded specialties.

The Eagle Oil & Supply Co., Boston, Mass., have sent us several of their calendars for the year 1900 which have fine and appropriate illustrations for each succeeding month.

We are also in receipt of a handsomely illustrated calendar from the Standard Tool Co., Cleveland, O.

WANTED.—Copies of MACHINERY, issue of January, 1898. State price. Address,
THE INDUSTRIAL PRESS, 9-15 Murray Street, New York.

WANTED.—Back numbers of MACHINERY. Will pay liberally for the following numbers: Vol. 1, No. 2; Vol. 2, No. 11; Vol. 3, Nos. 1, 2, 4, 6, 8, 9 and 10, or will buy whole of Vol. 3; Vol. 4, No. 5. CHAS M. SHAW, Hagerstown, Md.

WANTED.—Young man who is thoroughly posted on names and location of machinery manufacturers and other points necessary for catalogue work. Address, stating experience and salary desired, PERMANENT, care of MACHINERY, 9-15 Murray Street, New York.

A BELT LACE PATENT FOR SALE.—No holes in belt, no riveting or glueing, but a one piece metal that will hold the tightest belt and operate satisfactorily at the highest speed. The slack can be taken up instantly. I have no time to manufacture this article, but there is a fortune in it. Write quick and get full particulars and a sample. MICHAEL PARIDON, Box 96, New Portage, Ohio

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WANTED.—A small novelty that will sell through the mail. Send full particulars to MANUFACTURER, care of MACHINERY, 9-15 Murray Street, New York.

WANTED.—Mechanical engineer to take charge of machine shop for building all kinds of machines. Must be draughtsman. State past experience. Address S. M. G., care of MACHINERY, 9-15 Murray Street, New York.

WANTED.—Three thoroughly experienced machinery blacksmiths, accustomed to working to drawings; also one foreman blacksmith capable of handling forty men on general work including high class machine forging. Address "B," care of MACHINERY, 9-15 Murray Street, New York.

CONTENTS FOR FEBRUARY.